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(21)Application number : 2001-135310 (71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 02.05.2001 (72)Inventor : NAGUMO SHOJI
ONAKA KENGO
ISHIHARA TAKASHI
SATO HITOSHI

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(54) ANTENNA UNIT AND RADIO COMMUNICATION APPARATUS EQUIPPED THEREWITH

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an antenna unit having a plurality of frequency bands and realizing multiple resonance on each frequency band.
SOLUTION: A feed radiation electrode 14 which is split into branch radiation

electrodes 16 and 17 is provided on the surface of a base body 10, and non-feed radiation electrodes 18 and 19 are provided on each side of the feed radiation electrode 14 so as to be adjacent to the branch radiation electrodes 16 and 17 respectively. The branch radiation electrode 16 and the non-feed radiation electrode 18 start multiple resonances on the same frequency band, and the branch radiation electrode 17 and the non-feed radiation electrode 19 start multiple resonances on the same frequency band higher than that of the radiation electrodes 16 and 18.

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CLAIMS

[Claim(s)]
[Claim 1] The antenna equipment carry out having, making the base of a dielectric or the magnetic substance, the electric-supply component containing the electric-supply radiation electrode electrically combined with an electric-supply terminal area and this electric-supply terminal area, and two or more passive elements contain the non-supplied electric power radiation electrode electrically

combined with a grand terminal area and this grand terminal area meet the front face of said base with said electric-supply radiation electrode at said electric-supply radiation electrode, carrying out contiguity arrangement and constituting said non-supplied electric power radiation electrode as the description.

[Claim 2] Said electric supply radiation electrode is antenna equipment according to claim 1 characterized by constituting as a branching radiation electrode which carried out said electric supply terminal area in common, and was divided into plurality.

[Claim 3] Said each branching radiation electrode is antenna equipment according to claim 2 characterized by having the effective track length which excites with mutually different resonance frequency.

[Claim 4] It is antenna equipment according to claim 1 to which this single radiation electrode is characterized by having the effective track length which excites with the resonance frequency of a fundamental wave, and the resonance frequency of the high order higher harmonic by electric supply from said electric supply terminal area while constituting said electric supply radiation electrode as a single radiation electrode.

[Claim 5] It is antenna equipment according to claim 2 or 3 which elongates said non-supplied electric power radiation electrode from said grand terminal area, constitutes an other end side in an open end, and is characterized by the configuration which keeps away mutually said open end side in said branching radiation electrode, and arranges it while elongating said each branching radiation electrode from said electric supply terminal area and constituting an other end side in an open end.

[Claim 6] Antenna equipment of any one publication of claim 1 characterized by having used the side face of said base for the open end of each of said radiation electrode, and preparing a capacity loading electrode thru/or claim 5.

[Claim 7] Antenna equipment of any one publication of claim 1 characterized by arranging other one of said the non-supplied electric power radiation electrodes along said other-end side while having the rectangular circuit board, bringing near said base by part for the corner which two edge sides of said circuit board cross, fixing and arranging one of said the non-supplied electric power radiation electrodes along with one [said] edge side thru/or claim 6.

[Claim 8] The electric supply component containing the electric supply radiation electrode prolonged from an electric supply terminal area and this electric supply terminal area, Two or more antennas in which the passive element containing the non-supplied electric power radiation electrode prolonged from a grand electrode and this grand electrode was formed on the surface of the base, It has the circuit board which installs said antenna. The electric supply radiation electrode of each of said antenna, and a non-supplied electric power radiation electrode Antenna equipment characterized by preparing the grand pattern which connects said each grand electrode to said circuit board, and the electric supply pattern which connects said

each electric supply terminal area to the common source of a signal while having mutually different effective track length.

[Claim 9] Antenna equipment according to claim 8 characterized by establishing a filter circuit in the path which branched from the part which connects said source of a signal of said electric supply pattern towards said each electric supply terminal area.

[Claim 10] Antenna equipment according to claim 8 or 9 characterized by approaching the both sides of each of said electric supply radiation electrode, and arranging a non-supplied electric power radiation electrode in the front face of each of said base, respectively.

[Claim 11] Said electric supply terminal area is antenna equipment of any one publication of claim 1 characterized by being the terminal pin which penetrates the electric supply electrode formed in the side face of said base, or said base thru/or claim 10.

[Claim 12] Have the circuit board of the shape of a long and slender rectangle which has antenna equipment, and the shorter side and long side of any one publication of claim 1 thru/or claim 6, and the width of face of said antenna equipment is constituted almost equally to the die length of the shorter side of said circuit board. While arranging said antenna equipment along one shorter side of said circuit board, and both long sides Wireless radios characterized by turning the open end of said one non-supplied electric power radiation electrode to one long side of said circuit board, arranging it, turning the open end of one non-supplied electric power radiation electrode besides the above to the long side of said another side, and arranging it.

[Claim 13] It elongates from said electric supply terminal area, and said electric supply radiation electrode constitutes an other end side in an open end. Said non-supplied electric power radiation electrode While elongating from said grand terminal area and constituting an other end side in an open end Wireless radios according to claim 12 characterized by installing the open end side of the maximum ** in the non-supplied electric power radiation electrode which has the longest effective track length among the effective track length of said non-supplied electric power radiation electrode in the direction of the maximum far edge and reverse sense of a long side of the circuit board.

[Claim 14] Wireless radios characterized by connecting said electric supply terminal area with the antenna equipment of any one publication of said claim 1 thru/or claim 11 at the input/output terminal of said transceiver circuit while having the circuit board including the transceiver circuit of radio frequency and connecting the grand terminal area of said antenna equipment to the earth terminal of said circuit board.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to antenna equipment, and the antenna equipment of a multi-band and the wireless radios using this antenna equipment especially.

[0002]

[Background of the Invention] In recent years, in each country, the cellular phone of the so-called dual band which uses two frequency bands, for example, a 800-900MHz frequency band, and a 1800-1900MHz frequency band is in use. Since it corresponds to such an inclination, the reverse female mold antenna which realizes two frequency bands with one antenna is proposed. For example, the antenna which resonates on the frequency of 1500MHz and 1900MHz is shown in JP,10-93332,A.

[0003] this antenna is shown in drawing 15 -- as -- a conductor -- two radiation from which a slit 2 is formed in a plate 1, and width of face and die length differ -- a conductor -- plates 3 and 4 -- making -- moreover, a conductor -- some plates 1 -- bending -- connection -- a conductor -- a plate 5 -- making -- this connection -- a conductor -- a plate 5 -- radiation -- a conductor -- plates 3 and 4 -- touch-down -- a conductor -- a plate 6 top -- supporting -- the electric-supply pin 7 -- using -- radiation -- a conductor -- it is the configuration which supplies high-frequency power to plates 3 and 4.

[0004] Moreover, two metal patterns with which electric length differs are formed in the case front face of telephone, two radiating elements are formed in JP,2000-196326,A, and the configuration excited with the resonance frequency of 900MHz and 1800MHz is shown. The description of this antenna is adjusting the bandwidth of resonance frequency by the slit prepared between two metal patterns.

[0005]

[Problem(s) to be Solved by the Invention] However, although the above-mentioned conventional example is the antenna of the dual band in which both have two resonance frequency which the frequency band left, it serves as the single resonance characteristic in each frequency band. For this reason, the dimension of an antenna cannot become large inevitably to secure required bandwidth in each resonance frequency, and the miniaturization of an antenna cannot be realized. Moreover, like the conventional example, if each frequency band is constituted from single resonance, the resonance characteristic cannot serve as a single crest and broadband-ization cannot be attained.

[0006] Accomplishing this invention in order to solve the above-mentioned technical problem, the purpose has two or more frequency bands, and is to offer the antenna equipment which realized double resonance in each frequency band.

[0007] Moreover, other purposes of this invention are to offer the wireless radios using antenna equipment with two or more frequency bands which double-resonate.
[0008]
[Means for Solving the Problem] This invention is made into a means to solve a technical problem with the configuration shown below in order to attain the above-mentioned purpose. Namely, the electric supply component containing the electric supply radiation electrode with which it joins together as electrically [the antenna equipment of the 1st invention] as the base of a dielectric or the magnetic substance, and an electric supply terminal area and this electric supply terminal area, It has two or more passive elements containing the non-supplied electric power radiation electrode electrically combined with a grand terminal area and this grand terminal area, and on the surface of the base, an electric supply radiation electrode is made to meet with an electric supply radiation electrode, and it is carrying out as a means to solve a technical problem by being characterized by carrying out contiguity arrangement and constituting a non-supplied electric power radiation electrode.
[0009] In above-mentioned invention, an electric supply component resonates on one or more frequencies by supplying signal power to the electric supply terminal area which consists of an electric supply electrode or an electric supply pin. That is, an electric supply component resonates with the resonance frequency which becomes settled in the effective track length of each branching radiation electrode for every branching radiation electrode, when it resonates by the frequency of the fundamental wave which becomes settled in the effective track length of this electric supply radiation electrode when it has an electric supply radiation electrode with a single electric supply component, and its high order higher harmonic and an electric supply component has two or more branching radiation electrodes.
[0010] The passive element located in the right-hand side of an electric supply component among two or more passive elements Are constituted for a long time than the effective track length of the non-supplied electric power radiation electrode of a passive element with which the effective track length of the non-supplied electric power radiation electrode is located in the left-hand side of an electric supply component, and when it is an electric supply radiation electrode with a single electric supply component When it resonates on the frequency near the frequency of the fundamental wave and an electric supply component consists of two or more branching radiation electrodes, it resonates on the frequency near the lowest resonance frequency among the branching radiation electrode. And the passive element of left-hand side with the shortest effective track length resonates on the frequency near [in the high order higher harmonic in a single electric supply radiation electrode / one] the resonance frequency, or resonates on the frequency near [highest] the resonance frequency of a branching radiation electrode.
[0011] The resonance frequency which approached can be made to live together by

actuation which the electric supply component and the passive element mentioned above, and adjustment of the double resonance in each frequency band is acquired. Moreover, since the resonance frequency of the fundamental wave and high order higher harmonic of an electric supply component and the resonance frequency in each branching radiation electrode detach and set up a frequency band, they can make two or more double resonance live together without a mutual intervention at one antenna, and become possible [setting up widely bandwidth / in / by double resonance / in ** / each frequency band]. Here, the resonance frequency of an electric supply component and a passive element approaches here, here double resonance lives together, and it says that extensive bandwidth is obtained in this resonance frequency.

[0012] With the antenna equipment of the 2nd invention, the electric supply radiation electrode is characterized by constituting as a branching radiation electrode which carried out the electric supply terminal area in common, and was divided into plurality in above-mentioned invention.

[0013] By adoption of this configuration, the effective track length of two or more branching radiation electrodes can be considered as a different configuration. Thereby, as for an electric supply component, two or more different resonance frequency of a frequency lives together. If it puts in another way, while being able to set the resonance frequency in each branching radiation electrode as mutually different resonance frequency, resonance frequency of each branching radiation electrode can be made into the resonance frequency belonging to a different frequency band.

[0014] In the 2nd invention, each branching radiation electrode consists of antenna equipment of the 3rd invention considering having the effective track length which excites with mutually different resonance frequency as a description.

[0015] According to this invention, since it is excited with the independent resonance frequency, respectively, two or more branching radiation electrodes can form a frequency band which sets it as high resonance frequency according to the order of an array of a branching radiation electrode, and is different for every resonance frequency of such. For example, when an electric supply radiation electrode is constituted as a branching radiation electrode divided into two, one resonance frequency is set up as a thing belonging to the 800-900MHz band currently used with the cellular phone, and the resonance frequency of another side can be set up so that it may belong to a 1800-1900MHz band. Moreover, it becomes possible to excite one branching radiation electrode by the fundamental wave of an electric supply component, and to excite the branching radiation electrode of another side on the frequency of the high order higher harmonic of a fundamental wave, for example, 2 double wave, and a 3 time wave.

[0016] While the antenna equipment of the 4th invention constitutes an electric supply radiation electrode as a single radiation electrode in the 1st invention, this single radiation electrode is constituted considering having the effective track length

which excites with the resonance frequency of a fundamental wave, and the resonance frequency of that high order higher harmonic by electric supply from an electric supply terminal area as a description.

[0017] In this invention, the electric supply radiation electrode is constituted by the effective track length which resonates on the frequency of a fundamental wave, and the electric supply component serves as electric die length (electric merit) which resonates on the frequency of a fundamental wave and its integral multiple. Therefore, another frequency can be assigned to the frequency of 2 double wave of a fundamental wave, or a 3 time wave by assigning the lowest frequency to the resonance frequency of a fundamental wave among the frequencies to be used.

[0018] With the antenna equipment of the 5th invention, in the 2nd or 3rd above-mentioned invention, a non-supplied electric power radiation electrode is elongated from a grand terminal area, an other end side is constituted in an open end, and each branching radiation electrode is characterized by the configuration which keeps away mutually the open end side in a branching radiation electrode, and arranges it while it elongates from an electric supply terminal area and it constitutes an other end side in an open end.

[0019] Adoption of this configuration can constitute one double resonance pair (double resonance pair) from one branching radiation electrode and the non-supplied electric power radiation electrode close to this. In order to divide an electric supply radiation electrode into two or more branching radiation electrodes at this time, by extending the slit prepared all over the field of an electric supply radiation electrode as much as possible toward an open end from an electric supply terminal area side, the mutual intervention between double resonance pairs decreases, and good double resonance matching is obtained.

[0020] The antenna equipment of the 6th invention is constituted in above-mentioned invention [which] considering having used the side face of a base for the open end of each radiation electrode, and having prepared the capacity loading electrode as a description.

[0021] By this configuration, the fringing capacity by the side of the open end of each radiation electrode (stray capacity) can be decided proper as an open end capacity between a capacity loading electrode and the grand pattern of the circuit board (electrostatic capacity). It becomes easy to balance the joint capacity between an electric supply component and a passive element here, and it becomes easy to adjust [of double resonance-ization in the same frequency band].

[0022] In above-mentioned invention [which], the antenna equipment of the 7th invention is constituted considering arranging other one of the non-supplied electric power radiation electrodes along the other-end side as a description while having the rectangular circuit board, bringing near a base by part for the corner which two edge sides of the circuit board cross, fixing and arranging one of the non-supplied electric

power radiation electrodes along with one edge side.

[0023] In this invention, since the grand pattern and circuit pattern which were formed in the circuit board serve as a path of the high frequency current, a case current is excited along with each edge side of the circuit board which carried out electric-field association with each passive element. These case currents serve to raise the gain of the passive element which is indirect electric supply. Moreover, since electric-field association of a passive element and the circuit board is eased and excessive electric Q at the time of resonance falls by having brought near the base of antenna equipment by part for the corner of the circuit board, and having arranged it, the bandwidth of the double resonance in each frequency band can be extended.

[0024] The electric supply component which contains the electric supply radiation electrode prolonged from an electric supply terminal area and this electric supply terminal area with the antenna equipment of the 8th invention, Two or more antennas in which the passive element containing the non-supplied electric power radiation electrode prolonged from a grand electrode and this grand electrode was formed on the surface of the base, It has the circuit board which installs an antenna. The electric supply radiation electrode of each antenna, and a non-supplied electric power radiation electrode While having mutually different effective track length, the circuit board constitutes as a description having prepared the grand pattern which connects each grand electrode, and the electric supply pattern which connects each electric supply terminal area to the common source of a signal.

[0025] According to this invention, the circuit board becomes some antenna equipments and the electric volume of antenna equipment becomes settled in the area of the circuit board. That is, when antenna equipment is constituted on a large scale and a transmitting output is enlarged, the design in consideration of the engine performance required of extent of a mutual intervention, the directivity of an antenna, etc. also of arrangement of two or more antennas which receive the circuit board is attained that what is necessary is just to enlarge the dimension of the circuit board. Moreover, each antenna consists of different frequency bands as an antenna which double-resonates, and since it is possible to pass the big signal current from the source of a signal, it can raise the transmitting output of antenna equipment to an electric supply pattern.

[0026] In the 8th invention, the path which branched from the part which connects the source of a signal of an electric supply pattern towards each electric supply terminal area constitutes having prepared the filter circuit from antenna equipment of the 9th invention as a description.

[0027] Only the signal of the frequency band which signals other than the signal of the frequency band where each antenna is excited are intercepted, and excites each antenna is supplied to each antenna by adoption of this configuration. Therefore, separation of the frequency band between each antenna becomes good.

[0028] With the antenna equipment of the 10th invention, it is characterized by approaching the both sides of each electric supply radiation electrode, and arranging a non-supplied electric power radiation electrode in the front face of each base, respectively in the 8th or 9th invention.

[0029] In this invention, each antenna can consist of two frequency bands as an antenna which double-resonates, respectively by arranging the non-supplied electric power radiation electrode with which effective track length differs on both sides of an electric supply radiation electrode. Antenna equipment can have at least four or more frequency bands, and serves as an antenna of a multi-band by setting it as the band of a different frequency here.

[0030] In above-mentioned invention [which], the electric supply terminal area consists of antenna equipment of the 11th invention considering being the terminal pin which penetrates the electric supply electrode or base formed in the side face of a base as a description.

[0031] By adoption of this configuration, selection of the structure of an electric supply terminal area can be performed, and the configuration of it is attained in antenna equipment at either an inverted L type antenna or a reverse female mold antenna based on the specification demanded.

[0032] The 1st [above-mentioned in the wireless radios of the 12th invention] thru/or which [6th] antenna equipment, While having the circuit board of the shape of a long and slender rectangle which has a shorter side and a long side, constituting the width of face of antenna equipment almost equally to the die length of the shorter side of the circuit board and arranging antenna equipment along one shorter side of the circuit board, and both long sides It constitutes turning the open end of one non-supplied electric power radiation electrode to one long side of the circuit board, arranging it, turning the open end of other one non-supplied electric power radiation electrode to the long side of another side, and arranging it as a description.

[0033] According to this invention, the case current which belongs to two frequency bands along with the long side and shorter side of the circuit board by the passive element is excited. Thereby, the gain of the passive element arranged at the edge side of the circuit board becomes high. Moreover, since the open end of two non-supplied electric power radiation electrodes arranged along with the long side and shorter side of the circuit board serves as opposite sense, the mutual intervention between adjoining passive elements becomes small, and separation of a frequency band becomes good.

[0034] Furthermore, since the methods of three of antenna equipment are located in the edge side of the circuit board, in the passive element arranged at the edge side of the circuit board, electric-field association with a passive element and the circuit board is eased, electric Q of the double resonance characteristic falls, and frequency bandwidth becomes large. When the resonance conditions of the case current excited

by the edge side of the circuit board agree to the resonance frequency which belongs to any one frequency band of the passive element especially, high gain is acquired in the resonance frequency.

[0035] In the wireless radios of the 13th invention, it sets to the 12th invention. An electric supply radiation electrode It elongates from an electric supply terminal area, and an other end side is constituted in an open end. A non-supplied electric power radiation electrode While elongating from a grand terminal area and constituting an other end side in an open end, it constitutes as a description installing the open end side of the maximum ** in the non-supplied electric power radiation electrode which has the longest effective track length among the effective track length of a non-supplied electric power radiation electrode in the direction of the maximum far edge and reverse sense of a long side of the circuit board.

[0036] By this configuration, the substrate edge of the long side of the circuit board functions as an antenna of the low frequency band in antenna equipment, and high gain is acquired. Especially, in the frequency of the 800-900MHz band in a small cellular phone, the gain of an antenna becomes remarkably high.

[0037] Having connected the electric supply terminal area with the 1st thru/or which [11th] antenna equipment at the input/output terminal of a transceiver circuit, while having the circuit board including the transceiver circuit of radio frequency and connecting the grand terminal area of antenna equipment to the earth terminal of the circuit board consists of wireless radios of the 14th invention as a description.

[0038] By this configuration, the communication link of the large multi-band of frequency bandwidth of wireless radios is attained by mounting one antenna equipment.

[0039]

[Embodiment of the Invention] Below, the example of an operation gestalt concerning this invention is explained based on a drawing. Drawing 1 shows the basic configuration of the antenna equipment concerning this invention. Moreover, drawing 2 shows the characteristic curve of the double resonance in the antenna equipment of drawing 1 . In addition, in order to simplify the following explanation, the example of a gestalt using two electric supply components and two passive elements is shown.

[0040] In drawing 1 , a base 10 is made using dielectric materials and has the front face of a right-angle quadrilateral. The electric supply component 11 is formed, and a passive element 12 approaches the right-hand side of the electric supply component 11, and it is arranged in it by the front face of a base 10, and the passive element 12 and the passive element 13 from which resonance frequency differs are approached and arranged in it on the left-hand side of the electric supply component 11.

[0041] The electric supply component 11 is equipped with the electric supply terminal area 15 connected to electric supply edge 14a of the electric supply radiation electrode 14 and this electric supply radiation electrode 14. The electric supply

radiation electrode 14 is equipped with the branching radiation electrodes 16 and 17 with which electric supply edge 14a is carried out in common, and it branches in the shape of abbreviation for Y characters, and die length differs. Moreover, passive elements 12 and 13 are equipped with the grand terminal areas 20 and 21 connected to the touch-down edges 18a and 19a of the strip non-supplied electric power radiation electrodes 18 and 19 and these non-supplied electric power radiation electrodes 18 and 19, respectively.

[0042] The side left distantly [a / electric supply edge 14], respectively is constituted by open ends 16b and 17b, and, as for the branching radiation electrodes 16 and 17 of the electric supply component 11, the branching radiation electrode 16 has the effective track length which excites with resonance frequency f1, and the branching radiation electrode 17 has the effective track length which excites with resonance frequency f2. If signal power is supplied through the impedance matching circuit 23 from the source 22 of a signal connected to the electric supply terminal area 15 to these branching radiation electrodes 16 and 17, the electric supply component 11 will be excited with two resonance frequency f1 and f2 (f2> f1).

[0043] If it puts in another way, the electric supply component 11 will have the two electric heads of the electric merit who contains the branching radiation electrode 17 with the electric merit containing the branching radiation electrode 16, and the branching radiation electrode 16 side will resonate with resonance frequency f1, and the branching radiation electrode 17 side will resonate with resonance frequency f2. It is separated from the frequency band where resonance frequency f1 belongs, and the frequency band where resonance frequency f2 belongs to extent without the need of taking a mutual intervention into consideration.

[0044] Moreover, like the electric supply component 11, the furthest side from the touch-down edges 18a and 19a is constituted by open ends 18b and 19b, and the non-supplied electric power radiation electrodes 18 and 19 of passive elements 12 and 13 are excited by electromagnetic-field association with the electric supply component 11. That is, the non-supplied electric power radiation electrode 18 of a passive element 12 mainly carries out electromagnetic-field association with the branching radiation electrode 16 of the electric supply component 11, and is excited, and the non-supplied electric power radiation electrode 19 of a passive element 13 mainly carries out electromagnetic-field association with the branching radiation electrode 17 of the electric supply component 11, and is excited.

[0045] In this case, the non-supplied electric power radiation electrode 18 of a passive element 12 has effective track length almost equal to the branching radiation electrode 16, and the electric merit of the passive element 12 containing the grand terminal area 20 is shorter than the electric merit by the side of the branching radiation electrode 16 of the electric supply component 11 a little, and it is excited on the frequency f3 close to the resonance frequency f1 by the side of the branching

radiation electrode 16 of the electric supply component 11.

[0046] Moreover, the non-supplied electric power radiation electrode 19 of a passive element 13 is effective track length almost equal to the branching radiation electrode 17, its electric merit of the passive element 13 containing the grand terminal area 21 is shorter than the electric merit by the side of the branching radiation electrode 17 of the electric supply component 11 a little, and it is excited on the frequency f4 close to the resonance frequency f2 by the side of the branching radiation electrode 17. In addition, the impedance matching circuit 23 serves to adjust the impedance of the electric supply radiation electrode 14, and the impedance of the source 22 of a signal.

[0047] In an above-mentioned configuration the branching radiation electrode 16 and the non-supplied electric power radiation electrode 18 It is set to the effective track length excited in a common frequency band, for example, the effective track length which resonates in a 800-900MHz frequency band. Moreover, the branching radiation electrode 16 and the non-supplied electric power radiation electrode 18 It is set to the effective track length excited in a frequency band higher than the resonance frequency f1 of the branching radiation electrode 16, for example, the effective track length which resonates in a 1800-1900MHz frequency band.

[0048] Spacing of the side edge which the branching radiation electrode 16 in the electric supply radiation electrode 14 and the branching radiation electrode 17 face is spreading gradually toward open ends 16b and 17b, and has mainly prevented degradation of the resonance characteristic by the mutual intervention of electric-field association. Moreover, although the non-supplied electric power radiation electrodes 18 and 19 approach the branching radiation electrodes 16 and 17 and are arranged, respectively The branching radiation electrodes 16 and 17 and the non-supplied electric power radiation electrodes 18 and 19 face each other, and spacing of the extending side edge Rather than spacing of the earth side 18a and 19a of electric supply side 14a of the electric supply radiation electrode 14, and the non-supplied electric power radiation electrodes 18 and 19 The direction of the open endb [16] and 17b sides of the branching radiation electrodes 16 and 17 and the non-supplied electric power radiation electrode 18 and open end [by the side of 19] sides 18b and 19b is constituted widely, and too much electric-field association of the electric supply component 11 and passive elements 12 and 13 is adjusted.

[0049] If a sending signal is supplied to the electric supply radiation electrode 14 from the source 22 of a signal, the branching radiation electrodes 16 and 17 of the electric supply component 11 will be excited with the resonance frequency f1 and f2 according to individual by the above-mentioned configuration, respectively. Although passive elements 12 and 13 are excited by the electric supply component 11 and electromagnetic-field association at this time, electric-field association by the side of open end side of open end [of field association in the electric supply terminal area 15 and the grand terminal areas 20 and 21 and the branching radiation electrodes 16 and

17]b [16] and 17b and non-supplied electric power radiation electrodes 18 and 19 18b and 19b is mainly adjusted by the electrode disposition which the electric supply component 11 and passive elements 12 and 13 mentioned above.

[0050] This becomes the resonance characteristic which the resonance frequency f1 in the branching radiation electrode 16 and the resonance frequency f3 in the non-supplied electric power radiation electrode 18 lived together and approached, for example, it double-resonates in a 800-900MHz frequency band. Similarly, the resonance frequency f2 in the branching radiation electrode 17 and the resonance frequency f4 in the non-supplied electric power radiation electrode 19 also double-resonate at the frequencies f3 and f4 higher than the resonance frequency f1 and f2 of the branching radiation electrode 16 and the non-supplied electric power radiation electrode 18, for example, a 1800-1900MHz frequency band.

[0051] Drawing 3 shows other basic configurations of the antenna equipment concerning this invention. In addition, the same sign is given to the same component as the example of an operation gestalt of drawing 1 , and duplication explanation of the intersection is omitted. This example of an operation gestalt has the description in the point which constituted the electric supply radiation electrode 14 of the electric supply component 11 from three branching radiation electrodes 16, 17, and 24.

[0052] In drawing 3 , the electric supply radiating element 11 consists of electric supply radiation electrodes 14 equipped with three branching radiation electrodes 16, 17, and 24. That is, the electric supply radiation electrode 14 is the configuration that the branching radiation electrodes 16, 17, and 24 with which die length differs branched from common electric supply edge 14a in the shape of abbreviation for W characters. If it details the particulars, between the branching radiation electrodes 16 and 17 shown in drawing 1 is extended, and the 3rd branching radiation electrode 24 is formed in the middle, and it is constituted.

[0053] This branching radiation electrode 24 has the middle effective track length of the branching radiation electrode 16 and the branching radiation electrode 17, and is excited with the resonance frequency f5 (f2>f5> f1) belonging to the frequency band distant from the frequency band where the branching radiation electrodes 16 and 17 belong. Thereby, the electric supply component 11 is equipped with three electric merits, and has the resonance frequency f1, f2, and f5 belonging to three frequency bands.

[0054] On the other hand, the passive element 25 which constitutes the branching radiation electrode 24 and a double resonance pair is formed in the rear face of a base 10. That is, non-supplied electric power radiation electrode 25a elongated along with the branching radiation electrode 24 is formed in the rear face of a base 10. This non-supplied electric power radiation electrode 25a is also the same configuration as the non-supplied electric power radiation electrodes 18 and 19, and that touch-down edge is connected to the grand terminal area.

[0055] This non-supplied electric power radiation electrode 25a is considering electromagnetic-field association as the branching radiation electrode 24, has effective track length almost equal to the branching radiation electrode 24, and is excited on the frequency f6 close to the resonance frequency f5 of the branching radiation electrode 24. The resonance frequency f5 of the branching radiation electrode 24 and the resonance frequency f6 of non-supplied electric power radiation electrode 25a are double-resonating in the same frequency band, separate from each frequency band where the resonance frequency f3 and f4 of passive elements 12 and 13 belongs, and exist. In addition, the non-supplied electric power radiation electrodes 18 and 19 of passive elements 12 and 13 as well as non-supplied electric power radiation electrode 25a may be formed in the rear face of a base 10. Thereby, a base 26 can be constituted small.

[0056] The concrete example of the 1st operation gestalt of the antenna equipment applied to this invention using drawing 4 and drawing 5 is explained. Drawing 4 shows antenna equipment and drawing 5 shows the gestalt which mounted antenna equipment in the circuit board. In addition, this example of an operation gestalt is also explained using two electric supply components and two passive elements.

[0057] In drawing 4 , antenna equipment is constituted using the base 26 with rectangular surface 26e. A base 26 consists of a dielectric or the magnetic substance, such as a ceramic ingredient and a resin ingredient, and tabular two feet 28 and 29 and these bipeds 28 and 29 in which surface 26e was prepared along with the short hand side edges 26a and 26b of the longitudinal direction both ends of the flat top plate 27 and this top plate 27, and the central foot 30 prepared in the center of a top plate 27 in parallel are formed in one.

[0058] The electric supply component 31 and two passive elements 32 and 33 arranged in the both sides of this electric supply component 31 are formed in surface 26e of a base 26. Moreover, it brings near by the one side of the direction of a short hand, and three strip electrodes 36, 37, and 38 prolonged from the base side of a foot 28 in parallel with the direction (the vertical direction) of surface 26e of a base 26 are formed in one short hand side face (foot side face) of a base 26 at fixed spacing. A central electrode turns into the electric supply electrode 36, right-hand side serves as the 1st grand electrode 37, and, as for the electrode of both sides, left-hand side serves as the 2nd grand electrode 38. Moreover, these lower limits serve as surroundings lump and electric supply terminal 36a and the grand terminals 37a and 38a at base 28a of a foot 28, respectively.

[0059] The upper limit of the electric supply electrode 36 is connected to the electric supply radiation electrode 40 formed in surface 26e of a base 26. The electric supply radiation electrode 40 is formed in the configuration which spreads gradually toward the direction of a corner of the left-hand side in surface 26e from the electric supply electrode 36. Moreover, slit 40a of three long and slender square shapes which spread

toward the direction of a corner is prepared all over a field, and this electric supply radiation electrode 40 is constituted by the branching radiation electrodes 41 and 42 which branched into two.

[0060] That is, the 1st branching radiation electrode 41 is a configuration which spreads gradually, and is prolonged toward other short hand side edge 26b of base surface 26e near the electric supply electrode 36, and sets this short hand side edge 26b to open end 41a. Moreover, the 2nd branching radiation electrode 42 which approaches this 1st branching radiation electrode 41 through slit 40a is a configuration which is prolonged, carries out termination and forms open end 42a so that it may spread gradually toward 26d of longitudinal side edges of the left-hand side which extends in the longitudinal direction of a base 26 near the electric supply electrode 36. By this configuration, as for the 1st branching radiation electrode 41, effective track length becomes long rather than the 2nd branching radiation electrode 42.

[0061] Two non-supplied electric power radiation electrodes 43 and 44 are approached and formed in the both sides of the electric supply radiation electrode 40. That is, the 1st nothing electric supply radiation electrode 43 vacates spacing for the right-hand of the 1st branching radiation electrode 41, is arranged, and to short hand side edge 26b which counters from short hand side edge 26a of the upper limit of the 1st grand electrode 37, it develops in the shape of a quadrilateral, and it is formed. All over the field of this 1st nothing electric supply radiation electrode 43, slit 43a prolonged in parallel with right-hand side longitudinal side edge 26c is prepared from short hand side edge 26a, by this slit 43a, all of longitudinal side edge 26c are set to open end 43b, and open end 43c of the maximum ** is set to short hand side edge 26a by the side of the 1st grand electrode 37.

[0062] Moreover, the 2nd nothing electric supply radiation electrode 44 vacates spacing for the left-hand of the 2nd branching radiation electrode 42, is arranged, to 26d of longitudinal side edges of the left-hand side set to open end 44a from short hand side edge 26a by the side of the 2nd grand electrode 38, spreads in the shape of a triangle, and is formed. By this configuration, the effective track length of the 2nd nothing electric supply radiation electrode 44 becomes shorter than the effective track length of the 1st nothing electric supply radiation electrode 43. In addition, the open end 41a and 42a side consists of widely between the electric supply electrode 36 and the grand electrodes 37 and 38, and, as for spacing between the electric supply radiation electrode 40, the non-supplied electric power radiation electrode 43, and 44, the strength of electric-field association between the electric supply component 31, a passive element 32, and 33 is adjusted.

[0063] The strip capacity loading electrode 48 which is connected to open end 41a of the 1st branching radiation electrode 41, and hangs from short hand side edge 26b is formed in the short hand side face 34 in_which the electric supply electrode 36 in a

base 26 was formed, and the short hand side face 35 which counters, the lower limit has countered through the grounded fixed electrode 52 and fixed spacing, and a predetermined open-end capacity is formed between the capacity loading electrode 48 and a fixed electrode 52.

[0064] Moreover, the capacity loading electrode 49 which is connected to open end 42a of the 2nd branching radiation electrode 42, and hangs the side face of the central foot 30 from 26d of longitudinal side edges is formed in the longitudinal side face 47 which forms 26d of longitudinal side edges of a base 26. Furthermore, the side face of a foot 28 is used for the longitudinal side face 47, and the capacity loading electrode 51 which is connected to open end 44a of the 2nd nothing electric supply radiation electrode 44, and hangs from 26d of longitudinal side edges is formed in it.

[0065] Similarly, the capacity loading electrode 50 connected to open end 43b of the 1st nothing electric supply radiation electrode 43 using each side face of three feet 28, 29, and 30 is hung and formed in the longitudinal side face 47 in a base 26, and the longitudinal side face 46 which counters from longitudinal side edge 43b. In addition, the fixed electrodes 52 and 53 for fixing to the circuit board which mentions antenna equipment later turn also to the base of feet 28 and 29, and are formed in the lower part of the short hand side faces 34 and 35.

[0066] Above-mentioned antenna equipment is carried in the circuit board 55 of wireless radios, as shown in drawing 5 . Antenna equipment turns the electric supply electrode 36 to shorter side 55a of the circuit board 55, and is brought near and installed in the corner, and short hand side edge 26a of a base 26 is arranged along with shorter side 55a of the circuit board 55, and longitudinal side edge 26c of a base 26 is arranged along with long side 55c of the circuit board 55.

[0067] Namely, open end 43b of the non-supplied electric power radiation electrode 43 in a passive element 32 adjoins long side 55c of the circuit board 55. And the direction of open end 43c which open end 43c of the maximum ** adjoined shorter side 55a of the same circuit board 55 as the electric supply electrode 36, and turned up by slit 43a It has sense contrary to the extended direction of long side 55c of the circuit board 55 seen from the electric supply electrode 36 of antenna equipment, and the direction of another shorter side 55b which will counter with shorter side 55a if it puts in another way.

[0068] Moreover, open end 44a of the non-supplied electric power radiation electrode 44 in a passive element 33 has turned to the direction of long side 55c of the circuit board 55, and 55d of long sides of another side which counters, and has become the extended direction of shorter side 55a and the same direction which were seen from the electric supply electrode 36.

[0069] Like ****, the grand pattern is formed in the mounting position of antenna equipment except for the surroundings of the circuit pattern which mounts the circuit pattern used as the input/output terminal of the transceiver circuit which is not

illustrated which connects electric supply terminal 36a, and other passive circuit elements, for example, the passive circuit elements which form an impedance matching circuit, and the bases 28a, 29a, and 30a of feet 28, 29, and 30 established in the base 26 of antenna equipment are fixed to the circuit board 55 by which antenna equipment is arranged.

[0070] That is, electric supply terminal 36a is soldered to the input/output terminal of a transceiver circuit, and the grand terminals 37a and 38a and fixed electrodes 52 and 53 are soldered to the grand pattern. In addition, it may change to these soldering and contact by a spring nature elasticity pin etc. is sufficient. Moreover, the tip of the capacity loading electrodes 48, 49, 50, and 51 has countered with the grand pattern, and open end capacity is formed between the capacity loading electrodes 48, 49, 50, and 51 and a grand pattern. In addition, a monolayer or the laminating circuit board is used for the circuit board 55, and digital disposal circuits, such as a transceiver circuit of radio frequency and baseband, are formed in it using a circuit pattern.

[0071] In an above-mentioned configuration, if signal power is supplied to the electric supply electrode 36 through an impedance matching circuit, the electric supply component 31 will be excited with two resonance frequency f1 and f2. That is, it is excited with the resonance frequency f1 contained in a 800-900MHz frequency band, and the short 2nd branching radiation electrode 42 of effective track length is more expensive than the resonance frequency f1 of the 1st branching radiation electrode 41, for example, the long 1st branching radiation electrode 41 of effective track length is excited with the resonance frequency f2 contained in a 1800-1900MHz frequency band.

[0072] This two resonance frequency f1 and f2 lives together as independent resonance frequency by electric-field association between the 1st branching radiation electrode 41 and the 2nd branching radiation electrode 42 being eased by open end 41a and slit 40a expanded toward the direction of 42a, and setting up appropriately capacity coupling between the capacity loading electrodes 48 and 49 and a grand pattern. If it puts in another way, the electric supply component 31 has the two resonance characteristics which carried out mutually-independent by two electric merits decided with two branching radiation electrodes 41 and 42, two capacity loading electrodes 48 and 49, and electric supply electrodes 36.

[0073] Moreover, a passive element 32 receives supply of exciting power by the electromagnetic coupling with the electric supply component 31. If it puts in another way, a passive element 32 will mainly be excited with resonance frequency f3 by current (field) association in the parts of the electric supply electrode 36 and the grand electrode 37, electric-field association between the non-supplied electric power radiation electrode 43 and the 1st branching radiation electrode 41, and capacity coupling between three the capacity loading electrodes 50 and grand patterns. This resonance frequency f3 is set up in the same frequency band as the

resonance frequency f1 of the 1st branching radiation electrode 41, for example, a 800-900MHz frequency band.

[0074] At this time, the 1st nothing electric supply radiation electrode 43 is resonating with the resonance frequency [a little] f3 lower than the 1st branching radiation electrode 41, and the electric supply component 31 and a passive element 32 double-resonate with resonance frequency f1 and f3. The frequency bandwidth which resonance frequency f1 and f3 resonated here double, and formed in it turns into large frequency bandwidth compared with the resonance characteristic of the single resonance frequency f1 and f3.

[0075] Moreover, a case current is excited along with long side 55c of the circuit board 55 by the resonance current which flows toward open end 43c of the maximum ** of the 1st nothing electric supply radiation electrode 43. This case current makes gain of a passive element 32 high, when the die length of long side 55c of the circuit board 55 is the die length (lambda/2) of the abbreviation one half of the wavelength lambda of the electric wave to be used. Therefore, as for the die length of long side 55c of the circuit board 55, it is desirable that it is mostly in agreement with the wavelength of the resonance frequency which realizes high interest profit-ization.

[0076] Furthermore, by having approached long side 55c of the circuit board 55, and having arranged the 1st nothing electric supply radiation electrode 43, electric-field association with open ends 43b and 43c and a grand pattern decreases, electric Q of the resonance characteristic becomes low, and frequency bandwidth becomes large.

[0077] Similarly, a passive element 33 receives supply of exciting power by the electromagnetic coupling with the electric supply component 31. That is, a passive element 33 is mainly excited with resonance frequency f4 by current (field) association in the parts of the electric supply electrode 36 and the grand electrode 38, electric-field association with the 2nd nothing electric supply radiation electrode 44 and the 2nd branching radiation electrode 42, and capacity coupling between the capacity loading electrode 51 and a grand pattern. This resonance frequency f4 is set up in the same frequency band as the resonance frequency f2 of the 2nd branching radiation electrode 42, for example, a 1800-1900MHz frequency band.

[0078] This 2nd nothing electric supply radiation electrode 44 is excited with the resonance frequency [a little] f4 lower than the 2nd branching radiation electrode 42. And the electric supply component 31 and a passive element 33 double-resonate with resonance frequency f2 and f4, and the frequency bandwidth at that time becomes large compared with the resonance characteristic of the single resonance frequency f2 and f4. At this time, a case current is excited along with shorter side 55a of the circuit board 55 by the resonance current which flows toward open end 44a of the 2nd nothing electric supply radiation electrode 44.

[0079] According to this case current, the gain in a passive element 33 becomes high. Moreover, by having approached shorter side 55a of the circuit board 55, and having

arranged the 2nd nothing electric supply radiation electrode 44, electric-field association with open end 44a and a grand pattern decreases, and electric Q of the resonance characteristic becomes low and becomes the resonance characteristic with a large frequency band. Consequently, the frequency bandwidth of the double resonance characteristic also becomes large.

[0080] **** -- setting -- the [the 1st branching radiation electrode 41 of the electric supply component 31, and] -- the [in which the combination of 1 non-supplied electric power radiation electrode 43 forms the 1st frequency band] -- 1 double resonance pair -- constituting -- the [the 2nd branching radiation electrode 42 and] -- the [which the combination of 2 non-supplied electric power radiation electrodes 44 separates from the 1st frequency band, and forms the 2nd frequency band of a frequency higher than the 1st frequency band] -- 2 double resonance pair is constituted. Therefore, antenna equipment serves as an antenna of the dual band which double-resonated also in which frequency band, became the resonance characteristic of ****, and realized broadband width of face.

[0081] In addition, it can arrange the circuit which turns into a part of transceiver circuit, using the space between the central foot 30 and the feet 28 and 29 of both sides while it can attain lightweight-ization of a base 26, since a base 26 is the configuration which supported the top plate 27 on foot 28, 29, and 30. Moreover, since the thick taste of a top plate 27 becomes thinner than the height of feet 28, 29, and 30, it can lower the effective specific inductive capacity of a base 26 irrespective of the height of a base 26. Therefore, too much electric-field association between the electric supply component 31, a passive element 32, and 33 can be controlled, and improvement in an antenna property can be aimed at.

[0082] The concrete example of the 2nd operation gestalt of the antenna equipment applied to this invention using drawing 6 and drawing 7 is explained. In addition, the same sign is given to the same component as the example of the 1st operation gestalt of drawing 4 , and duplication explanation of the intersection is omitted. The description of this example of an operation gestalt is to have constituted almost equally the width of face of one shorter side of the circuit board, and antenna equipment.

[0083] In drawing 6 , as for the circuit board 56 included in the case of a cellular phone, the ratio of long sides 56c and 56d and shorter sides 56a and 56b is produced by two to about four according to the width of face of a case. That longitudinal side edge 57c is arranged along with one shorter side 56a of the circuit board 56, and the base 57 of the antenna equipment mounted in this circuit board 56 serves as arrangement which the short hand side edges 57a and 57b meet in the long sides 56c and 56d of the circuit board 56. or [that longitudinal side edges / of the base 57 in this antenna equipment / 57c and 57d / die length is the same as the shorter sides 56a and 56b of the circuit board 56] -- or it is a dimension short a little.

[0084] Moreover, a base 57 is the box-like gestalt which prepared opening 58a in the base 58 side, and the thickness of top-plate 60 part is thinly constituted compared with the height of a side attachment wall 59. The electric supply component 61 and passive elements 62 and 63 are formed in surface 60a of a base 57 like drawing 4 . Unlike the case of drawing 4 , the electric supply electrode 36 and the grand electrodes 37 and 38 bias these electric supply component 61 and passive elements 62 and 63 toward the one side of longitudinal wall surface 59c, and it is prepared in longitudinal side-face 59c of a base 57.

[0085] Moreover, the open ends 43b and 43c which the non-supplied electric power radiation electrode 43 connected to the upper limit of the grand electrode 37 was prolonged to 57d of longitudinal side edges which counter from longitudinal side edge 57c, and were divided by slit 43a are connected to the capacity loading electrode 50 prepared in short hand wall surface 59a on the right-hand side of a base 57. On the other hand, the non-supplied electric power radiation electrode 44 connected to the grand electrode 38 is prolonged to left-hand side short hand side edge 57b along with longitudinal side edge 57c, and the open end 44a is connected to the capacity loading electrode 51 prepared in short hand wall surface 59b.

[0086] Between the non-supplied electric power radiation electrode 43 and the non-supplied electric power radiation electrode 44, the electric supply radiation electrode 40 which forms the electric supply component 61 is formed with the gestalt of the branching radiation electrodes 41 and 42 like drawing 4 , and open end 41a is connected to the capacity loading electrode 48 prepared in 59d of longitudinal wall surfaces, and open end 42a is connected to the capacity loading electrode 49 prepared in short hand wall surface 59b.

[0087] In an above-mentioned configuration, the 1st branching radiation electrode 41 and the non-supplied electric power radiation electrode 43 are constituted as a radiation electrode which constitutes a double resonance pair, for example, are double-resonating on the frequency of a 800-900MHz band. Moreover, the 2nd branching radiation electrode 42 and the non-supplied electric power radiation electrode 44 are also radiation electrodes which double-resonate on the frequency of a 1800-1900MHz band, and serve as a double resonance pair.

[0088] Moreover, while arranging open end 43b of the non-supplied electric power radiation electrode 43 along with long side 56c of the circuit board 56 Open end 43c of the maximum ** The extended direction (shorter side 56b side) and opposite sense of long side 56c, That is, since it is the configuration which carries out termination by longitudinal side edge 57c by the side of shorter side 56a in which the grand electrode 37 is located, the case current which belongs to a low frequency band side along with long side 56c of the circuit board 56 is excited, and the gain of an antenna improves remarkably.

[0089] Similarly, it arranges along with shorter side 56a of the circuit board 56, and it

elongates in the same direction as the extended direction of shorter side 56a, and the open end 44a carries out termination of the non-supplied electric power radiation electrode 44 belonging to a high frequency band side by short hand side edge 57b by the side of 56d of long sides of the circuit board 56. The case current which belongs to the substrate edge by the side of shorter side 56a of the circuit board 56 at a RF side, i.e., a case current with the frequency of a 1800-1900MHz band, is excited by this, and gain in a high frequency band is made high.

[0090] Since electric-field association with the non-supplied electric power radiation electrodes 43 and 44 and the circuit board 56 is eased on the occasion of excitation of the case current mentioned above by having arranged the non-supplied electric power radiation electrodes 43 and 44 at the substrate edge of the circuit board 56, it can control that electric Q of the resonance characteristic becomes high too much, and bandwidth can be extended. Moreover, open end 43b of the non-supplied electric power radiation electrode 43 is located in the long side 56c side of the circuit board 56, it is located in 56d side of long sides of the circuit board 56, and becomes the arrangement relation left most, the mutual intervention between two double resonance pairs becomes remarkably small, and open end 44a of the non-supplied electric power radiation electrode 44 can prevent degradation of the double resonance characteristic.

[0091] Drawing 8 shows the modification of the antenna equipment shown in drawing 7 . In addition, the same sign is given to the same component as the example of the 2nd operation gestalt of drawing 7 , and duplication explanation of the intersection is omitted. This example of an operation gestalt has the description in the point which extended greatly slit 40a formed in the electric supply radiation electrode 40, and constituted it.

[0092] In drawing 8 , the electric supply electrode 36 and the grand electrodes 37 and 38 are formed in the central part of the longitudinal direction in longitudinal wall surface 59c of a base 57 like drawing 7 . It elongates towards a part for the corner of the right end location of 57d of longitudinal side edges which counter from longitudinal side edge 57c, and the branching radiation electrode 41 has open end 41a in 57d of longitudinal side edges, and short hand side edge 57a, and is connected to the capacity loading electrode 48 prepared in the capacity loading electrode 66 and short hand wall surface 59a which were prepared in 59d of longitudinal wall surfaces. The tip of the capacity loading electrode 66 has countered with the fixed electrode 68 through fixed spacing.

[0093] On the other hand, it elongates towards a part for the corner of the left end location of 57d of longitudinal side edges, and the branching radiation electrode 42 has open end 42a in 57d of longitudinal side edges, and short hand side edge 57b, and is connected to the capacity loading electrode 49 prepared in the capacity loading electrode 67 and short hand wall surface 59b which were prepared in 59d of

longitudinal wall surfaces. The tip of the capacity loading electrode 67 has countered with the fixed electrode 69 through fixed spacing like ****.

[0094] moreover, the mutual intervention between two resonance frequency [in / slit 40a which divides the branching radiation electrodes 41 and 42 is the gestalt greatly opened toward 57d of longitudinal side edges from the electric-supply electrode 36 side, and / the branching radiation electrodes 41 and 42] -- if it puts in another way, the mutual intervention between the double resonance pairs of the double resonance pair of the branching radiation electrode 41 and the non-supplied electric power radiation electrode 43, the branching radiation electrode 42, and the non-supplied electric power radiation electrode 44 will make small.

[0095] The non-supplied electric power radiation electrode 43 is elongated toward right-hand side short hand side edge 57a, termination of the open ends 43b and 43c is carried out by short hand side edge 57a and longitudinal side edge 57c, and open end 43b is connected to two capacity loading electrodes 50. Moreover, the non-supplied electric power radiation electrode 44 is prolonged toward left-hand side short hand side edge 57b, and open end 44a located in short hand side edge 57b is connected to two capacity loading electrodes 51 prepared in short hand wall surface 59b.

[0096] In this configuration, since the open ends 41a and 42a of two branching radiation electrodes 41 and 42 are pulled apart to the maximum extent, the band separation between two double resonance pairs becomes good, and the property in each ****** pair improves. Moreover, since antenna equipment is mounted in the circuit board 56 with the same gestalt as drawing 6 and excites a case current at the substrate edges 56a and 56c like ****, its gain in each ****** pair improves.

[0097] Drawing 9 shows the concrete example of the 3rd operation gestalt of the antenna equipment concerning this invention. In addition, the same sign is given to the same component as the example of the 1st operation gestalt shown in drawing 4 , and duplication explanation of the intersection is omitted. The description of this example of an operation gestalt is in the point using an electric supply radiation electrode single for an electric supply component.

[0098] In drawing 9 , the electric supply component 71 is constituted as a single electric supply radiation electrode 72 which sets the upper limit of the electric supply electrode 36 to electric supply edge 72a. All over the field of the electric supply radiation electrode 72, two or more slit 72b is prepared from the side edge side of the elongation direction of a radiation electrode, and the effective track length of the electric supply radiation electrode 72 is set up suitably. While the capacity loading electrode 48 prepared in the short hand side face 35 is connected, the capacity loading electrode 73 prepared in the longitudinal side face 47 is connected to open end 72c of the electric supply radiation electrode 72. The capacity loading electrode 48 gives electrostatic capacity between fixed electrodes 52, and the capacity loading electrode 73 forms electrostatic capacity between the grand patterns of the circuit

board.

[0099] This electric supply component 71 is excited with the resonance frequency of the high order higher harmonic of a fundamental wave, for example, 2 double wave, and a 3 time wave while it will be excited with the resonance frequency of a fundamental wave, if signal power is supplied through the electric supply electrode 36. The resonance frequency of a fundamental wave belongs to the same frequency band as the resonance frequency of a passive element 32, and the electric supply component 71 and a passive element 32 double-resonate. Moreover, the resonance frequency of the high order higher harmonic in the electric supply component 71 belongs to the same frequency band as the resonance frequency of a passive element 33, and the electric supply component 71 and a passive element 33 double-resonate on a frequency higher than a passive element 32. In addition, although **** showed the example of a gestalt which performs a setup of the fundamental wave in the electric supply radiation electrode 72, and a high order higher harmonic by formation of slit 72b, it is not limited to this.

[0100] Although each showed the gestalt which connected the electric supply radiation electrodes 40 and 72 to the electric supply electrode 36 in the above-mentioned example of an operation gestalt, it is good also as a configuration which separates the upper limit of the electric supply electrode 36 from the electric supply radiation electrodes 40 and 72, and prepares and carries out capacity coupling of the fixed spacing (gap).

[0101] Moreover, as shown in drawing 10 , the electric supply electrode 74 can be formed in the side face of the base 75 by the side of open end 41a of the branching radiation electrodes 41 and 42, and 42a. The tip of this electric supply electrode 74 is close with open ends 41a and 42a through fixed spacing, and carries out capacity coupling to the branching radiation electrodes 41 and 42. With this electric supply structure, fundamental edge 40b of the branching radiation electrodes 41 and 42 is grounded through a grand electrode. If it puts in another way, the electric supply electrode 36 in the above-mentioned example of an operation gestalt will be used as a grand electrode.

[0102] Furthermore, as shown in drawing 11 , it is good also as a configuration which penetrates the top plate 27 of a base 26 in the location used as about 50 ohms for root headquarters of the branching radiation electrodes 41 and 42, stands the electric supply pin 76 to it, and supplies signal power to it at the branching radiation electrodes 41 and 42. The lower limit of the electric supply pin 76 is connected to the electric supply pattern 77 prepared in the circuit board 55. It is the same as drawing 4 except permuting the electric supply electrode 36 by the grand electrode also in this electric supply structure.

[0103] Drawing 12 shows the concrete example of the 4th operation gestalt of the antenna equipment concerning this invention. This antenna equipment has the

description in the point which mounted two single antennas in the circuit board, and constituted the antenna of a dual band.

[0104] In drawing 12 , on the circuit board 80, two single antennas 81 and 82 isolate between fixed, and are mounted. These single antennas 81 and 82 are equipped with the electric supply components 83 and 84 and passive elements 85 and 86 which were formed using bases 87 and 88, respectively. And it is the configuration that the electric supply components 83 and 84 adjoin and passive elements 85 and 86 are arranged on the outside of the electric supply components 83 and 84. In addition, the configuration of bases 87 and 88 is the same as that of drawing 7 .

[0105] The single antenna 81 equips the short hand side face of a base 87 with the electric supply electrode 89 and the grand electrode 91 which are prolonged up and down, it approaches and this electric supply electrode 89 and the grand electrode 91 are arranged so that the electric supply electrode 89 may be located in the left and the grand electrode 91 may be located in the right. Moreover, the non-supplied electric power radiation electrode 95 linked to the upper limit of the grand electrode 91 develops straightly, and is constituted from same width of face as the longitudinal direction of a base 87 by the front face of a base 87 like drawing 4 , and the open end is connected to the capacity loading electrode 97 prepared in the longitudinal side face of a base 87.

[0106] the electric supply radiation electrode 93 prepared in the base 87 on the other hand -- the longitudinal direction of the upper limit of the electric supply electrode 89 to the base 87 -- and it curves gradually, and is elongated and prepared so that it may separate from the non-supplied electric power radiation electrode 95. The open end of the electric supply radiation electrode 93 is connected to the capacity loading electrode 98 prepared in the location near the electric supply electrode 89 in the near longitudinal side face facing the single antenna 82. In addition, all over the field of the electric supply radiation electrode 93, slit 93a is prepared from the electric supply electrode 89 side, and adjustment of the effective track length of the electric supply radiation electrode 93 is performed.

[0107] Moreover, with the single antenna 82, like the single antenna 81, the electric supply electrode 90 and the grand electrode 92 arrange the electric supply electrode 90 on the right, arrange the grand electrode 92 on the left, and it is prepared in the short hand side face of a base 88. In the front face of a base 88, the non-supplied electric power radiation electrode 96 linked to the upper limit of the grand electrode 92 is elongating the left-hand side of a base 88 by the same width of face toward a longitudinal direction, and the capacity loading electrode 99 prepared in the longitudinal side face of a base 88 is connected to the open end by the side of the tip on it.

[0108] And after elongating from the upper limit of the electric supply electrode 90 to the middle of the longitudinal direction of a base 88, it curves in the shape of radii, and

the electric supply radiation electrode 94 is formed so that it may separate from the non-supplied electric power radiation electrode 96 rapidly. That is, the effective track length of the electric supply radiation electrode 94 is constituted shorter than the effective track length of the electric supply radiation electrode 93. It connects with the capacity loading electrode 100 brought near and prepared in the longitudinal side face facing the single antenna 81 side at the electric supply electrode 90 side at the open end of the electric supply radiation electrode 94. In addition, 101 is a fixed electrode.

[0109] The common electric supply terminal pattern 102 prepared in the substrate edge part and the electric supply pattern 103,104 connected to this electric supply terminal pattern 102 are formed in the circuit board 80 which mounted two single antennas 81 and 82. The electric supply electrode 89 of the single antenna 81 is connected to the electric supply pattern 103, and the electric supply electrode 90 of the single antenna 82 is connected to the electric supply pattern 104. In addition, the grand electrodes 90 and 91 and a fixed electrode 101 are connected to the grand pattern which is not illustrated, and the tip of each capacity loading electrodes 97, 98, and 99,100 has countered with the grand pattern which is not illustrated.

[0110] In an above-mentioned configuration, the electric supply component 83 and passive element 85 of the single antenna 81 are double-**(ed) in the same frequency band, for example, a 800-900MHz frequency band. Moreover, the electric supply component 84 and passive element 86 of the single antenna 82 are also double-**(ed) in the frequency band where a frequency higher than the frequency band of the single antenna 81 is the same, for example, a 1800-1900MHz frequency band. Therefore, antenna equipment carries out the work as the branching electrode which considered the electric supply terminal pattern 102 as a part for root headquarters with the electric supply radiation electrodes 93 and 94 same [**] like the electric supply component 31 shown in drawing 4 .

[0111] Moreover, the antenna equipment constituted using this circuit board 80 can be considered as the configuration which extends spacing between the single antenna 81 and 82 according to the size of the circuit board 80, and can make small enough the mutual intervention between the single antenna 81 and 82. Moreover, the electric volume of the antenna equipment demanded according to an application can also be decided with the dimension of the circuit board 80, and an arrangement change of the single antennas 81 and 82 can also be made easily.

[0112] Moreover, the band cutoff circuit 105,106 can be established in the antenna equipment shown in the example of an operation gestalt of drawing 12 in the middle of like [drawing 13] and the electric supply pattern 103,104. That is, the band cutoff circuit 105 is a filter network which passes the signal which intercepts the signal belonging to the frequency band of the single antenna 82, and belongs to the frequency band of the single antenna 81. Moreover, the band cutoff circuit 106 is a

filter network which passes the signal which intercepts the signal belonging to the frequency band of the single antenna 81, and belongs to the frequency band of the single antenna 82.

[0113] By this circuitry, each ** antennas 81 and 82 can form an electric supply component only in consideration of the excitation conditions in each frequency band, and adjustment of double resonance becomes easy.

[0114] In the example of an operation gestalt shown in drawing 12 and drawing 13 , the single antennas 81 and 82 can be permuted by the antenna equipment shown in drawing 4 , and can be constituted. That is, each of the single antennas 81 and 82 is considered as the configuration which arranged the passive element in the both sides of an electric supply component. Since each ** antennas 81 and 82 constitute the antenna of the dual band which had two frequency bands, respectively, this antenna equipment serves as an antenna of a multi-band with a total of four frequency bands. Therefore, by carrying this antenna equipment in wireless radios, each frequency band can be used, switching it one by one, and can be used for coincidence.

[0115] Moreover, the single antennas 81 and 82 of the antenna equipment shown in drawing 13 and the single antenna 107 of the same configuration can be added and constituted. As the single antenna 107 is shown in drawing 14 , it is arranged among the single antennas 81 and 82, and the electric supply electrode is connected to the electric supply terminal pattern 102 through the electric supply pattern 108. In the middle of the electric supply pattern 108, the filter network 109 is formed like the single antennas 81 and 82.

[0116] The electric supply component of the single antenna 107 and the passive element are also double-resonating, and antenna equipment turns into antenna equipment with three frequency bands. For example, when the single antenna 81 is assigned to a 800-900MHz frequency band, a 1800-1900MHz frequency band can be considered as the configuration which assigned the 2700-2800MHz frequency band to the single antenna 82 again at the single antenna 107.

[0117]

[Effect of the Invention] Since according to the antenna equipment of claim 1 an electric supply component is made to meet and contiguity arrangement of the passive element is carried out, the optimal electromagnetic-field association between each passive element and electric supply component can be set up for every passive element, and good double resonance can be realized for every frequency band where the resonance frequency of each passive element belongs. therefore, since the bandwidth in each frequency band is boiled markedly and becomes large compared with the antenna which makes two frequency bands like the conventional example the single resonance characteristic, respectively, broadband-ization of antenna equipment is attained. this -- following -- antenna equipment -- a miniaturization -- and the low back can be formed.

[0118] Since an electric supply radiation electrode is constituted as two or more branching radiation electrodes, two or more resonance frequency belonging to a frequency band which is different for one electric supply component can be made to live together according to the antenna equipment of claim 2. Moreover, since each branching radiation electrode has each effective track length, it can set up resonance frequency according to an individual.

[0119] According to the antenna equipment of claim 3, resonance frequency can be set up freely in the range with which the frequency band where each resonance frequency belongs does not lap since each branching radiation electrode is equipped with the effective track length which excites with mutually different resonance frequency, and the frequency used for every branching radiation electrode can be assigned.

[0120] Since one electric supply radiation electrode is equipped with the effective track length which excites with the resonance frequency of a fundamental wave, and the resonance frequency of the high order higher harmonic according to the antenna equipment of claim 4, it is not necessary to prepare a branching radiation electrode for every resonance frequency, the volume of the part and antenna equipment can be made small, and antenna equipment can be miniaturized.

[0121] Since it considers as the configuration which extended spacing by the side of the open end of the adjoining branching radiation electrode in an electric supply component according to the antenna equipment of claim 5, it comes out degradation of the double resonance characteristic by the mutual intervention between double resonance pairs and to prevent contraction of frequency bandwidth and the fall of antenna gain especially.

[0122] According to the antenna equipment of claim 6, since the capacity loading electrode was prepared in the open end of a radiation electrode, it is obtained as a definite value, and a setup of the resonance frequency in each radiation electrode becomes easy by this, and the open end capacity in each radiation electrode can obtain good double resonance matching.

[0123] According to the antenna equipment of claim 7, they can realize broadband-ization in each passive element, respectively while they can form these passive elements into high interest profit, since at least two non-supplied electric power radiation electrodes are arranged along with the edge side of the circuit board.

[0124] Since two or more antennas are mounted and constituted in the circuit board, while according to the antenna equipment of claim 8 being able to decide the volume of an antenna with the dimension of the circuit board and attaining enlargement of antenna equipment, the design of antenna equipment -- layout modification of each antenna becomes easy -- becomes easy.

[0125] According to the antenna equipment of claim 9, since signal power is supplied to each antenna through a filter circuit, the design of the electric supply component

which was able to take adjustment for each antenna of every becomes easy.

[0126] Since each antenna is constituted from two frequency bands as an antenna which double-resonates, respectively according to the antenna equipment of claim 10, while the antenna of a multi-band is easily realizable, the tooth space of antenna loading in wireless radios can be made small.

[0127] According to the antenna equipment of claim 11, since the selection width of face of the configuration of an electric supply terminal area spreads, the design of antenna equipment becomes easy.

[0128] Since according to the wireless radios of claim 12 antenna equipment is arranged along with the edge side of the methods of three of the circuit board while constituting the width of face of antenna equipment almost equally to the die length of the shorter side of the circuit board, while being able to use the tooth space of the circuit board effectively, a case current can be excited to the circuit board and extensive gain-ization of antenna equipment can be attained. Moreover, since it considered as the arrangement which kept away the open end of a non-supplied electric power radiation electrode as much as possible, and controlled electric-field association, double resonance of a broadband is obtained and interference between frequency bands can be made small.

[0129] According to the wireless radios of claim 13, since the open end side of the maximum ** in the non-supplied electric power radiation electrode of a low frequency was prepared in the direction of the maximum far edge and reverse sense of a long side of the circuit board, the circuit board can be utilized as an antenna of a low frequency, and high interest profit-ization of an antenna can be attained.

[0130] Since the antenna equipment which has a large frequency band by double resonance, and has two or more frequency bands is used according to the wireless radios of claim 14, one antenna equipment can realize radio using two or more frequency bands, and much more miniaturization of wireless radios is attained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the approximate account Fig. showing the basic configuration of the antenna equipment concerning this invention.

[Drawing 2] It is the frequency-characteristics Fig. showing the return loss of the antenna equipment in drawing 1 .

[Drawing 3] It is other approximate account Figs. showing the basic configuration of the antenna equipment concerning this invention, and (A) is a surface Fig. and (B) is a rear-face Fig.

[Drawing 4] The example of an operation gestalt of the antenna equipment concerning this invention is shown, (A) is a surface perspective view and (B) is a rear-face perspective view.

[Drawing 5] It is the top view showing the example of an operation gestalt which mounted the antenna equipment of drawing 4 in the circuit board of wireless radios.

[Drawing 6] It is the top view showing other examples of an operation gestalt which mounted antenna equipment in the circuit board of wireless radios.

[Drawing 7] Other examples of an operation gestalt of the antenna equipment concerning this invention are shown, (A) is a surface perspective view and (B) is a rear-face perspective view.

[Drawing 8] The example of an operation gestalt of further others of the antenna equipment concerning this invention is shown, (A) is a surface perspective view and (B) is a rear-face perspective view.

[Drawing 9] The example of an operation gestalt of further others of the antenna equipment concerning this invention is shown, (A) is a surface perspective view and (B) is a rear-face perspective view.

[Drawing 10] It is the perspective view showing other configurations of the electric supply terminal area concerning the antenna equipment of this invention.

[Drawing 11] The configuration of further others of the electric supply terminal area concerning the antenna equipment of this invention is shown, and it is a sectional view [in / (A) and / in (B) / one point broken-line X-X of (A)]. [a top view]

[Drawing 12] The example of an operation gestalt of further others of the antenna equipment concerning this invention is shown, and (A) is the rear-face perspective view of a single antenna which used a surface perspective view, (B), and (C) by (A).

[Drawing 13] It is the perspective view showing other examples of an operation gestalt concerning the antenna equipment of drawing 12 .

[Drawing 14] It is the top view showing the example of an operation gestalt of further others of the antenna equipment concerning this invention.

[Drawing 15] It is the perspective view showing the antenna equipment of the conventional example.

[Description of Notations]

10, 26, 57, 75, 87, 88 Base

11, 31, 61, 71, 83, 84 Electric supply component

12, 13, 25, 32, 33, 62, 63, 85, 86 Passive element

14, 40, 72, 93, 94 Electric supply radiation electrode

16, 17, 24, 41, 42 Branching radiation electrode

16b, 17b, 18b, 19b, 41a, 42a, 43b, 43c, 44a, 72c Open end

18, 19, 43, 44, 95, 96, 25a Non-supplied electric power radiation electrode

22 Source of Signal

23 Impedance Matching Circuit

36, 74, 89, 90 Electric supply electrode

37, 38, 91, 92 Grand electrode

43a Slit

48, 49, 50, 51, 66, 67, 73, 97, 98, 99,100 Capacity loading electrode

55, 56, 80 Circuit board

55a, 55b, 56a, 56b Shorter side

55c, 55d, 56c, 56d Long side

76 Electric Supply Pin

77,103,104,108 Electric supply pattern

81 82,107 Single antenna

102 Electric Supply Terminal Pattern

105,106,109 Band cutoff circuit

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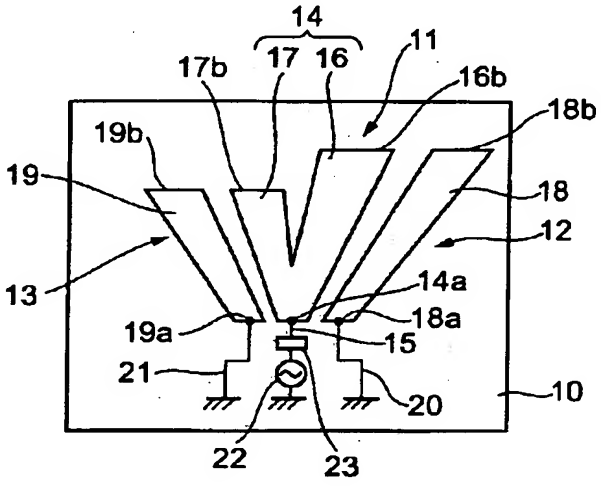
(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者　南雲　正二
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(72)発明者　尾仲　健吾
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(74)代理人　100093894
弁理士　五十嵐　清

最終頁に続く

(54)【発明の名称】　アンテナ装置及びこのアンテナ装置を備えた無線通信機

(57)【要約】
【課題】　アンテナ装置が複数の周波数帯域を持ち且つ各周波数帯域で複共振を実現する。
【解決手段】　基体１０の表面に、２つの分岐放射電極１６，１７に分けた給電放射電極１４を設け、この給電放射電極１４の両側には、夫々の分岐放射電極１６，１７に近接して無給電放射電極１８，１９を設ける。分岐放射電極１６と無給電放射電極１８は、同じ周波数帯域で複共振し、また、分岐放射電極１７と無給電放射電極１９は、分岐放射電極１６と無給電放射電極１８の周波数帯域よりも高い周波数の同じ周波数帯域で複共振する。



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【特許請求の範囲】

【請求項１】　誘電体又は磁性体の基体と、給電端子部及び該給電端子部と電気的に結合する給電放射電極を含む給電素子と、グランド端子部及び該グランド端子部と電気的に結合する無給電放射電極を含む複数の無給電素子とを備え、前記基体の表面には、前記給電放射電極と共に前記給電放射電極に沿わせて前記無給電放射電極を近接配置して構成することを特徴とするアンテナ装置。

【請求項２】　前記給電放射電極は、前記給電端子部を共通にして複数に分かれた分岐放射電極として構成することを特徴とする請求項１に記載のアンテナ装置。

【請求項３】　前記各分岐放射電極は、互いに異なる共振周波数で励振する実効線路長を備えることを特徴とする請求項２に記載のアンテナ装置。

【請求項４】　前記給電放射電極を単一放射電極として構成すると共に、該単一放射電極は、前記給電端子部からの給電により、基本波の共振周波数及びその高次高調波の共振周波数で励振する実効線路長を備えることを特徴とする請求項１に記載のアンテナ装置。

【請求項５】　前記無給電放射電極は、前記グランド端子部から伸張して他端側を開放端に構成し、前記各分岐放射電極は、前記給電端子部から伸張して他端側を開放端に構成すると共に、前記分岐放射電極に於ける前記開放端側を互いに遠ざけて配設する構成を特徴とする請求項２又は請求項３に記載のアンテナ装置。

【請求項６】　前記各放射電極の開放端に、前記基体の側面を用いて容量装荷電極を設けたことを特徴とする請求項１乃至請求項５の何れか１つに記載のアンテナ装置。

【請求項７】　方形の回路基板を備え、前記基体を前記回路基板の２つの端辺が交わる角部分に寄せて固定し、前記無給電放射電極の１つを前記一方の端辺に沿って配置すると共に、前記無給電放射電極の他の１つを前記他方の端辺に沿って配置することを特徴とする請求項１乃至請求項６の何れか１つに記載のアンテナ装置。

【請求項８】　給電端子部及び該給電端子部から延びる給電放射電極を含む給電素子と、グランド電極及び該グランド電極から延びる無給電放射電極を含む無給電素子とを基体の表面に形成した複数のアンテナと、前記アンテナを設置する回路基板とを備え、前記各アンテナの給電放射電極及び無給電放射電極は、互いに異なる実効線路長を備えると共に、前記回路基板には、前記各グランド電極を接続するグランドパターンと、前記各給電端子部を共通の信号源に接続する給電パターンとを設けたことを特徴とするアンテナ装置。

【請求項９】　前記給電パターンの前記信号源を接続する部位から前記各給電端子部へ向け枝分かれした経路にはフィルタ回路を設けたことを特徴とする請求項８に記載のアンテナ装置。

【請求項１０】　前記各基体の表面には、前記各給電放射電極の両側に近接して夫々無給電放射電極を配設することを特徴とする請求項８又は請求項９に記載のアンテナ装置。

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【請求項１１】　前記給電端子部は、前記基体の側面に形成した給電電極又は前記基体を貫通する端子ピンであることを特徴とする請求項１乃至請求項１０の何れか１つに記載のアンテナ装置。

【請求項１２】　請求項１乃至請求項６の何れか１つに記載のアンテナ装置と、短辺と長辺を有する細長い長方形状の回路基板を備え、前記アンテナ装置の幅を前記回路基板の短辺の長さとほぼ等しく構成して、前記アンテナ装置を前記回路基板の一方の短辺と両方の長辺に沿って配置すると共に、前記１つの無給電放射電極の開放端を前記回路基板の一方の長辺に向けて配置し、前記他の１つの無給電放射電極の開放端を前記他方の長辺に向けて配置することを特徴とする無線通信機。

【請求項１３】　前記給電放射電極は、前記給電端子部から伸張して他端側を開放端に構成し、前記無給電放射電極は、前記グランド端子部から伸張して他端側を開放端に構成すると共に、前記無給電放射電極の実効線路長の内、最も長い実効線路長を有する無給電放射電極に於ける最遠の開放端側を回路基板の長辺の最遠端方向と逆向きに設置することを特徴とする請求項１２に記載の無線通信機。

【請求項１４】　前記請求項１乃至請求項１１の何れか１つに記載のアンテナ装置と、無線周波の送受信回路を含む回路基板を備え、前記アンテナ装置のグランド端子部を前記回路基板の接地端子に接続すると共に前記給電端子部を前記送受信回路の入出力端子に接続したことを特徴とする無線通信機。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、アンテナ装置、特に、マルチバンドのアンテナ装置及びこのアンテナ装置を用いた無線通信機に関するものである。

【０００２】

【背景技術】近年、各国に於いて、２つの周波数帯域、例えば、８００～９００ＭＨｚの周波数帯域と、１８００～１９００ＭＨｚの周波数帯域を使用する、所謂デュアルバンドの携帯電話が主流となっている。このような傾向に対応するため、２つの周波数帯域を１つのアンテナで実現する逆Ｆ型アンテナが提案されている。例えば、特開平１０－９３３３２号公報には、１５００ＭＨｚと１９００ＭＨｚの周波数で共振するアンテナが示されている。

【０００３】このアンテナは、図１５に示すように、導体板１にスリット２を設けて幅と長さの異なる２つの放射導体板３，４を作り、また、導体板１の一部を折り曲げて接続導体板５を作り、この接続導体板５で放射導体板３，４を接地導体板６の上に支持し、給電ピン７を用

いて放射導体板３，４に高周波電力を供給する構成である。

【０００４】また、特開２０００－１９６３２６号公報には、電話機の筐体表面に電気長の異なる２つの金属パターンを形成して２つの放射素子を形成し、９００ＭＨｚと１８００ＭＨｚの共振周波数で励振する構成が示されている。このアンテナの特徴は、２つの金属パターンの間に設けたスリットにより共振周波数の帯域幅を調整していることである。

【０００５】

【発明が解決しようとする課題】しかしながら、上述の従来例は、両者共に、周波数帯域の離れた２つの共振周波数を持つデュアルバンドのアンテナであるが、夫々の周波数帯域では単一の共振特性となっている。このため、各共振周波数に於いて必要な帯域幅を確保するには必然的にアンテナの寸法が大きくなり、アンテナの小型化を実現することができない。また、従来例のように、各周波数帯域を単共振で構成すると、共振特性が単峰となり広帯域化を図ることができない。

【０００６】本発明は上記課題を解決するために成されたものであり、その目的は、複数の周波数帯域を持ち、夫々の周波数帯域で複共振を実現したアンテナ装置を提供することにある。

【０００７】また、本発明の他の目的は、複共振する複数の周波数帯域を持つアンテナ装置を用いた無線通信機を提供することにある。

【０００８】

【課題を解決するための手段】上記目的を達成するために、本発明は次に示す構成をもって課題を解決する手段としている。即ち、第１の発明のアンテナ装置は、誘電体又は磁性体の基体と、給電端子部及びこの給電端子部と電気的に結合する給電放射電極を含む給電素子と、グランド端子部及びこのグランド端子部と電気的に結合する無給電放射電極を含む複数の無給電素子とを備え、基体の表面には、給電放射電極と共に給電放射電極に沿わせて無給電放射電極を近接配置して構成することを特徴として課題を解決する手段としている。

【０００９】上述の発明に於いて、給電電極又は給電ピンからなる給電端子部に信号電力を供給することにより、給電素子は、１以上の周波数で共振する。即ち、給電素子は、給電素子が単一の給電放射電極を有するときには、この給電放射電極の実効線路長で定まる基本波の周波数及びその高次高調波で共振し、また、給電素子が複数の分岐放射電極を有するときには、分岐放射電極毎に各分岐放射電極の実効線路長で定まる共振周波数で共振する。

【００１０】複数の無給電素子の内、例えば、給電素子の右側に位置する無給電素子は、その無給電放射電極の実効線路長が給電素子の左側に位置する無給電素子の無給電放射電極の実効線路長よりも長く構成され、給電素子が単一の給電放射電極のときには、その基本波の周波数に近い周波数で共振し、また、給電素子が複数の分岐放射電極で構成されるときには、その分岐放射電極の内、最も低い共振周波数に近い周波数で共振する。そして、最も短い実効線路長を持つ左側の無給電素子は、単一の給電放射電極に於ける高次高調波に於ける１つの共振周波数近傍の周波数で共振し、又は分岐放射電極の最も高い共振周波数近傍の周波数で共振する。

【００１１】給電素子と無給電素子の上述した動作により、近接した共振周波数を共存させることができ、夫々の周波数帯域に於ける複共振の整合が得られる。また、給電素子の基本波と高次高調波の共振周波数及び各分岐放射電極に於ける共振周波数は、周波数帯域を離して設定するので、１つのアンテナに複数の複共振を相互干渉なく共存させることができ、而も、複共振により、各周波数帯域に於ける帯域幅を広く設定することが可能となる。ここに、複共振とは、給電素子と無給電素子の共振周波数が近接して共存し、この共振周波数に於いて広範な帯域幅が得られることをいう。

【００１２】第２の発明のアンテナ装置では、上述の発明に於いて、給電放射電極は、給電端子部を共通にして複数に分かれた分岐放射電極として構成することを特徴としている。

【００１３】この構成の採用により、複数の分岐放射電極の実効線路長を異なる構成とすることができる。これにより、給電素子は、周波数の異なる複数の共振周波数が共存するものとなる。換言すれば、夫々の分岐放射電極に於ける共振周波数を互いに異なる共振周波数に設定することができると共に、各分岐放射電極の共振周波数を異なる周波数帯域に属する共振周波数とすることができる。

【００１４】第３の発明のアンテナ装置では、第２の発明に於いて、各分岐放射電極は、互いに異なる共振周波数で励振する実効線路長を備えることを特徴として構成されている。

【００１５】この発明によれば、複数の分岐放射電極は、夫々、独立した共振周波数で励振されるので、分岐放射電極の配列順に従って高い共振周波数に設定し、且つこれらの共振周波数毎に異なる周波数帯域を形成することができる。例えば、給電放射電極を２つに分かれた分岐放射電極として構成した場合には、一方の共振周波数を、携帯電話で実用されている８００～９００ＭＨｚ帯に属するものとして設定し、他方の共振周波数を１８００～１９００ＭＨｚ帯に属する如く設定できる。また、一方の分岐放射電極を給電素子の基本波で励振し、他方の分岐放射電極を基本波の高次高調波、例えば、２倍波又は３倍波の周波数で励振することが可能となる。

【００１６】第４の発明のアンテナ装置は、第１の発明に於いて、給電放射電極を単一放射電極として構成すると共に、この単一放射電極は、給電端子部からの給電に

より、基本波の共振周波数及びその高次高調波の共振周波数で励振する実効線路長を備えることを特徴として構成されている。

【００１７】この発明に於いて、給電放射電極は、基本波の周波数で共振する実効線路長に構成されており、給電素子は、基本波及びその整数倍の周波数で共振する電気的な長さ（電気長）となっている。従って、使用する周波数の内、最も低い周波数を基本波の共振周波数に割当てることにより、もう１つの周波数を基本波の２倍波又は３倍波の周波数に割当てることができる。

【００１８】第５の発明のアンテナ装置では、上述の第２又は第３の発明に於いて、無給電放射電極は、グランド端子部から伸張して他端側を開放端に構成し、各分岐放射電極は、給電端子部から伸張して他端側を開放端に構成すると共に、分岐放射電極に於ける開放端側を互いに遠ざけて配設する構成を特徴としている。

【００１９】この構成の採用により、１つの分岐放射電極と、これに近接する無給電放射電極とで１つの複共振対（複共振ペア）を構成することができる。このとき、給電放射電極を複数の分岐放射電極に分けるため、給電放射電極の面中に設けたスリットを給電端子部側から開放端に向かって可能な限り広げることにより、複共振ペア間の相互干渉が少なくなり、良好な複共振マッチングが得られる。

【００２０】第６の発明のアンテナ装置は、上述の何れかの発明に於いて、各放射電極の開放端に、基体の側面を用いて容量装荷電極を設けたことを特徴として構成されている。

【００２１】この構成により、各放射電極の開放端側に於けるフリンジング容量（浮遊容量）は、容量装荷電極と回路基板のグランドパターン間の開放端容量（静電容量）として適正に確定することができる。ここに、給電素子と無給電素子間の結合容量とのバランスを取ることが容易となり、同じ周波数帯域に於ける複共振化の調整が容易となる。

【００２２】第７の発明のアンテナ装置は、上述の何れかの発明に於いて、方形の回路基板を備え、基体を回路基板の２つの端辺が交わる角部分に寄せて固定し、無給電放射電極の１つを一方の端辺に沿って配置すると共に、無給電放射電極の他の１つを他方の端辺に沿って配置することを特徴として構成されている。

【００２３】この発明に於いて、回路基板に形成したグランドパターン及び配線パターンは高周波電流の通路となるので、各無給電素子と電界結合した回路基板の夫々の端辺に沿って筐体電流が励起される。これらの筐体電流は、間接給電である無給電素子の利得を高める働きをする。また、アンテナ装置の基体を回路基板の角部分に寄せて配置したことにより、無給電素子と回路基板の電界結合が緩和されて共振時の過大な電気的Ｑが低下するので、夫々の周波数帯域に於ける複共振の帯域幅を広げることができる。

【００２４】第８の発明のアンテナ装置では、給電端子部及びこの給電端子部から延びる給電放射電極を含む給電素子と、グランド電極及びこのグランド電極から延びる無給電放射電極を含む無給電素子とを基体の表面に形成した複数のアンテナと、アンテナを設置する回路基板とを備え、各アンテナの給電放射電極及び無給電放射電極は、互いに異なる実効線路長を備えると共に、回路基板には、各グランド電極を接続するグランドパターンと、各給電端子部を共通の信号源に接続する給電パターンとを設けたことを特徴として構成されている。

【００２５】この発明によれば、回路基板はアンテナ装置の一部となり、アンテナ装置の電気的な体積は回路基板の面積で定まる。即ち、アンテナ装置を大型に構成して送信出力を大きくするときには、回路基板の寸法を大きくすれば良く、回路基板に対する複数のアンテナの配置も、相互干渉の程度やアンテナの指向性等に要求される性能を考慮した設計が可能となる。また、夫々のアンテナは、異なる周波数帯域で複共振するアンテナとして構成されており、給電パターンには、信号源から大きな信号電流を流すことが可能なため、アンテナ装置の送信出力を高めることができる。

【００２６】第９の発明のアンテナ装置では、第８の発明に於いて、給電パターンの信号源を接続する部位から各給電端子部へ向け枝分かれした経路にはフィルタ回路を設けたことを特徴として構成されている。

【００２７】この構成の採用により、各アンテナには、夫々のアンテナが励振される周波数帯域の信号以外の信号は遮断されて夫々のアンテナを励振する周波数帯域の信号のみが投入される。従って、各アンテナの間に於ける周波数帯域の分離が良好となる。

【００２８】第１０の発明のアンテナ装置では、第８又は第９の発明に於いて、各基体の表面には、各給電放射電極の両側に近接して夫々無給電放射電極を配設することを特徴としている。

【００２９】この発明に於いて、給電放射電極の両側に実効線路長の異なる無給電放射電極を配置することにより、各アンテナを、夫々、２つの周波数帯域で複共振するアンテナとして構成することができる。ここに、アンテナ装置は、少なくとも４つ以上の周波数帯域を持つことができ、異なる周波数の帯域に設定することにより、マルチバンドのアンテナとなる。

【００３０】第１１の発明のアンテナ装置では、上述の何れかの発明に於いて、給電端子部は、基体の側面に形成した給電電極又は基体を貫通する端子ピンであることを特徴として構成されている。

【００３１】この構成の採用により、給電端子部の構造の選択ができ、要求される仕様に基づき、アンテナ装置を逆Ｌ型アンテナ又は逆Ｆ型アンテナの何れにも構成可能となる。

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【００３２】第１２の発明の無線通信機では、上述の第１乃至第６の何れかのアンテナ装置と、短辺と長辺を有する細長い長方形状の回路基板を備え、アンテナ装置の幅を回路基板の短辺の長さとほぼ等しく構成して、アンテナ装置を回路基板の一方の短辺と両方の長辺に沿って配置すると共に、１つの無給電放射電極の開放端を回路基板の一方の長辺に向けて配置し、他の１つの無給電放射電極の開放端を他方の長辺に向けて配置することを特徴として構成されている。

【００３３】この発明によれば、無給電素子により、回路基板の長辺及び短辺に沿って２つの周波数帯域に属する筐体電流が励起される。これにより、回路基板の端辺に配置された無給電素子の利得が高くなる。また、回路基板の長辺及び短辺に沿って配置された２つの無給電放射電極の開放端が反対の向きとなるから、隣接の無給電素子間の相互干渉が小さくなり、周波数帯域の分離が良くなる。

【００３４】更に、アンテナ装置の３方が回路基板の端辺に位置するので、回路基板の端辺に配置された無給電素子に於いては、無給電素子と回路基板との電界結合が緩和され、複共振特性の電気的Ｑが低下して周波数帯域幅が広くなる。特に、無給電素子の何れか１つの周波数帯域に属する共振周波数に対し、回路基板の端辺に励起される筐体電流の共振条件が合致する場合には、その共振周波数に於いて高い利得が得られる。

【００３５】第１３の発明の無線通信機では、第１２の発明に於いて、給電放射電極は、給電端子部から伸張して他端側を開放端に構成し、無給電放射電極は、グランド端子部から伸張して他端側を開放端に構成すると共に、無給電放射電極の実効線路長の内、最も長い実効線路長を有する無給電放射電極に於ける最遠の開放端側を回路基板の長辺の最遠端方向と逆向きに設置することを特徴として構成されている。

【００３６】この構成により、回路基板の長辺の基板端は、アンテナ装置に於ける低い周波数帯域のアンテナとして機能し、高い利得が得られる。特に、小型の携帯電話に於ける８００～９００ＭＨｚ帯の周波数に於いてアンテナの利得が著しく高くなる。

【００３７】第１４の発明の無線通信機では、第１乃至第１１の何れかのアンテナ装置と、無線周波の送受信回路を含む回路基板を備え、アンテナ装置のグランド端子部を回路基板の接地端子に接続すると共に給電端子部を送受信回路の入出力端子に接続したことを特徴として構成されている。

【００３８】この構成により、無線通信機は、１つのアンテナ装置を実装することにより、周波数帯域幅の広いマルチバンドの通信が可能となる。

【００３９】

【発明の実施の形態】以下に、本発明に係る実施形態例を図面に基いて説明する。図１は、本発明に係るアンテナ装置の基本構成を示す。また、図２は、図１のアンテナ装置に於ける複共振の特性曲線を示す。なお、以下の説明を簡単にするため、２つの給電素子と２つの無給電素子を用いた形態例を示す。

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【００４０】図１に於いて、基体１０は、誘電体材料を用いて作られ、直角四辺形の表面を有する。基体１０の表面には、給電素子１１が形成されており、給電素子１１の右側には無給電素子１２が近接して配設され、また、給電素子１１の左側には、無給電素子１２と共振周波数の異なる無給電素子１３が近接して配設されている。

【００４１】給電素子１１は、給電放射電極１４と、この給電放射電極１４の給電端１４ａに接続された給電端子部１５を備えている。給電放射電極１４は、給電端１４ａを共通にして略Ｙ字状に枝分かれし、且つ長さの異なる分岐放射電極１６，１７を備えている。また、無給電素子１２，１３は、ストリップ状の無給電放射電極１８，１９と、この無給電放射電極１８，１９の接地端１８ａ，１９ａに夫々接続されたグランド端子部２０，２１を備えている。

【００４２】給電素子１１の分岐放射電極１６，１７は、夫々、給電端１４ａから遠く離れた側が開放端１６ｂ，１７ｂに構成されており、分岐放射電極１６は共振周波数ｆ１で励振する実効線路長を持ち、また、分岐放射電極１７は共振周波数ｆ２で励振する実効線路長を持っている。これらの分岐放射電極１６，１７に対し給電端子部１５に接続された信号源２２からインピーダンス整合回路２３を介して信号電力を供給すると、給電素子１１は、２つの共振周波数ｆ１，ｆ２（ｆ２>ｆ１）で励振する。

【００４３】換言すれば、給電素子１１は、分岐放射電極１６を含む電気長と分岐放射電極１７を含む電気長の２つの電気長を持っており、分岐放射電極１６側は共振周波数ｆ１で共振し、また、分岐放射電極１７側は共振周波数ｆ２で共振する。共振周波数ｆ１が属する周波数帯域と共振周波数ｆ２が属する周波数帯域は、相互干渉を考慮する必要のない程度に離れている。

【００４４】また、無給電素子１２，１３の無給電放射電極１８，１９は、給電素子１１と同様に、接地端１８ａ，１９ａから最も遠い側が開放端１８ｂ，１９ｂに構成され、給電素子１１との電磁界結合により励振される。即ち、無給電素子１２の無給電放射電極１８は、主に、給電素子１１の分岐放射電極１６と電磁界結合して励振され、無給電素子１３の無給電放射電極１９は、主に、給電素子１１の分岐放射電極１７と電磁界結合して励振される。

【００４５】この場合、無給電素子１２の無給電放射電極１８は、分岐放射電極１６とほぼ等しい実効線路長を持ち、グランド端子部２０を含んだ無給電素子１２の電気長は、給電素子１１の分岐放射電極１６側の電気長よ

りも若干短く、給電素子１１の分岐放射電極１６側の共振周波数ｆ１に近接した周波数ｆ３で励振される。

【００４６】また、無給電素子１３の無給電放射電極１９は、分岐放射電極１７とほぼ等しい実効線路長であり、グランド端子部２１を含んだ無給電素子１３の電気長は、給電素子１１の分岐放射電極１７側の電気長よりも若干短く、分岐放射電極１７側の共振周波数ｆ２に近接した周波数ｆ４で励振される。なお、インピーダンス整合回路２３は、給電放射電極１４のインピーダンスと信号源２２のインピーダンスを整合する働きをする。

【００４７】上述の構成に於いて、分岐放射電極１６及び無給電放射電極１８は、共通の周波数帯域で励振される実効線路長、例えば、８００～９００ＭＨｚの周波数帯域で共振する実効線路長に定められ、また、分岐放射電極１６及び無給電放射電極１８は、分岐放射電極１６の共振周波数ｆ１よりも高い周波数帯域で励振される実効線路長、例えば、１８００～１９００ＭＨｚの周波数帯域で共振する実効線路長に定められる。

【００４８】給電放射電極１４に於ける分岐放射電極１６と分岐放射電極１７の向い合う側縁の間隔は、開放端１６ｂ，１７ｂに向って次第に広がっており、主として、電界結合の相互干渉による共振特性の劣化を防いでいる。また、無給電放射電極１８，１９は、夫々、分岐放射電極１６，１７に近接して配設されるが、分岐放射電極１６，１７と無給電放射電極１８，１９の向い合って延在する側縁の間隔は、給電放射電極１４の給電側１４ａと無給電放射電極１８，１９の接地側１８ａ，１９ａの間隔よりも、分岐放射電極１６，１７の開放端１６ｂ，１７ｂと無給電放射電極１８，１９側の開放端側１８ｂ，１９ｂの方が広く構成されており、給電素子１１と無給電素子１２，１３の過度の電界結合を調整している。

【００４９】上述の構成により、信号源２２から送信信号を給電放射電極１４に供給すると、給電素子１１の分岐放射電極１６，１７は、夫々、個別の共振周波数ｆ１，ｆ２で励振される。このとき、無給電素子１２，１３は給電素子１１と電磁界結合により励振されるが、給電素子１１と無給電素子１２，１３の上述した電極配置により、主として、給電端子部１５とグランド端子部２０，２１に於ける磁界結合及び分岐放射電極１６，１７の開放端１６ｂ，１７ｂと無給電放射電極１８，１９の開放端側１８ｂ，１９ｂ側に於ける電界結合が調整される。

【００５０】これにより、分岐放射電極１６に於ける共振周波数ｆ１と無給電放射電極１８に於ける共振周波数ｆ３が共存し且つ近接した共振特性となり、例えば、８００～９００ＭＨｚの周波数帯域で複共振する。同様に、分岐放射電極１７に於ける共振周波数ｆ２と無給電放射電極１９に於ける共振周波数ｆ４も、分岐放射電極１６と無給電放射電極１８の共振周波数ｆ１、ｆ２よりも高い周波数ｆ３，ｆ４、例えば、１８００～１９００ＭＨｚの周波数帯域で複共振する。

【００５１】図３は本発明に係るアンテナ装置の他の基本構成を示す。なお、図１の実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。この実施形態例は、給電素子１１の給電放射電極１４を３つの分岐放射電極１６，１７，２４で構成した点に特徴がある。

【００５２】図３に於いて、給電放射素子１１は、３つの分岐放射電極１６，１７，２４を備えた給電放射電極１４で構成されている。即ち、給電放射電極１４は、共通の給電端１４ａから長さの異なる分岐放射電極１６，１７，２４が略Ｗ字状に枝分かれした構成である。詳言すれば、図１に示す分岐放射電極１６，１７の間を広げ、その中間に第３の分岐放射電極２４を設けて構成されている。

【００５３】この分岐放射電極２４は、分岐放射電極１６と分岐放射電極１７の中間の実効線路長を持ち、分岐放射電極１６，１７が属する周波数帯域から離れた周波数帯域に属する共振周波数ｆ５（ｆ２＞ｆ５＞ｆ１）で励振される。これにより、給電素子１１は、３つの電気長を備え、３つの周波数帯域に属する共振周波数ｆ１，ｆ２，ｆ５を持つものとなる。

【００５４】一方、分岐放射電極２４と複共振ペアを構成する無給電素子２５は、基体１０の裏面に設けられる。即ち、基体１０の裏面には、分岐放射電極２４に沿って伸張する無給電放射電極２５ａが形成されている。この無給電放射電極２５ａも無給電放射電極１８，１９と同様の構成であり、その接地端はグランド端子部に接続されている。

【００５５】この無給電放射電極２５ａは、分岐放射電極２４と電磁界結合をしており、分岐放射電極２４とほぼ等しい実効線路長を持ち、分岐放射電極２４の共振周波数ｆ５に近接した周波数ｆ６で励振される。分岐放射電極２４の共振周波数ｆ５と無給電放射電極２５ａの共振周波数ｆ６は、同じ周波数帯域に於いて複共振しており、無給電素子１２，１３の共振周波数ｆ３，ｆ４が属する夫々の周波数帯域から離れて存在する。なお、無給電素子１２，１３の無給電放射電極１８，１９も、無給電放射電極２５ａと同様に、基体１０の裏面に設けても良い。これにより、基体２６を小さく構成できる。

【００５６】図４及び図５を用いて本発明に係るアンテナ装置の具体的な第１実施形態例を説明する。図４はアンテナ装置を示し、図５はアンテナ装置を回路基板に実装した形態を示す。なお、この実施形態例も、２つの給電素子と２つの無給電素子を用いて説明する。

【００５７】図４に於いて、アンテナ装置は、長方形の表面２６ｅを持った基体２６を用いて構成される。基体２６は、セラミックス材料や樹脂材料等の誘電体或いは磁性体からなり、表面２６ｅが平坦な天板２７と、この

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天板２７の長手方向両端の短手側縁２６ａ，２６ｂに沿って設けられた板状の２つの脚２８，２９及びこれら両脚２８，２９と平行に且つ天板２７の中央に設けた中央脚３０とが一体に形成されている。

【００５８】基体２６の表面２６ｅには、給電素子３１と、この給電素子３１の両側に配設された２つの無給電素子３２，３３が形成されている。また、基体２６の一方の短手側面（脚側面）には、短手方向の一方側に寄せて、脚２８の底面側から基体２６の表面２６ｅ方向（上下方向）に平行に延びる３本のストリップ状の電極３６，３７，３８が一定の間隔で形成されている。中央の電極は給電電極３６となり、両側の電極は右側が第１グランド電極３７、左側が第２グランド電極３８となる。また、これらの下端は、夫々、脚２８の底面２８ａに回り込み、給電端子３６ａ及びグランド端子３７ａ，３８ａとなっている。

【００５９】給電電極３６の上端は、基体２６の表面２６ｅに形成された給電放射電極４０に接続されている。給電放射電極４０は、給電電極３６から表面２６ｅに於ける左側の角部方向に向かって次第に広がる形状に形成されている。また、この給電放射電極４０は、面中に、角部方向に向かって広がる細長い３角形のスリット４０ａが設けられ、２つに枝分かれした分岐放射電極４１，４２に構成されている。

【００６０】即ち、第１分岐放射電極４１は、給電電極３６の近傍から基体表面２６ｅの他の短手側縁２６ｂに向かって次第に広がって延び且つこの短手側縁２６ｂを開放端４１ａとする形状である。また、この第１分岐放射電極４１にスリット４０ａを介して近接する第２分岐放射電極４２は、給電電極３６の近傍から基体２６の長手方向に延びる左側の長手側縁２６ｄに向かって次第に広がる如く延びて終端し開放端４２ａを形成する形状である。この構成により、第１分岐放射電極４１は第２分岐放射電極４２よりも実効線路長が長くなる。

【００６１】給電放射電極４０の両側には、２つの無給電放射電極４３，４４が近接して形成されている。即ち、第１無給電放射電極４３は、第１分岐放射電極４１の右隣に間隔を空けて配置され、第１グランド電極３７の上端の短手側縁２６ａから対向する短手側縁２６ｂまで四辺形状に展開して形成される。この第１無給電放射電極４３の面中には、短手側縁２６ａから右側の長手側縁２６ｃと平行に延びるスリット４３ａが設けられており、このスリット４３ａにより、長手側縁２６ｃの全部が開放端４３ｂとなり、最遠の開放端４３ｃは、第１グランド電極３７側の短手側縁２６ａとなる。

【００６２】また、第２無給電放射電極４４は、第２分岐放射電極４２の左隣に間隔を空けて配置されており、第２グランド電極３８側の短手側縁２６ａから開放端４４ａとなる左側の長手側縁２６ｄまで三角形状に広がって形成されている。この構成により、第２無給電放射電極４４の実効線路長は、第１無給電放射電極４３の実効線路長よりも短くなる。なお、給電放射電極４０と無給電放射電極４３，４４間の間隔は、給電電極３６とグランド電極３７，３８の間よりも開放端４１ａ，４２ａ側が広く構成されており、給電素子３１と無給電素子３２，３３間の電界結合の強さが調整される。

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【００６３】基体２６に於ける給電電極３６を設けた短手側面３４と対向する短手側面３５には、第１分岐放射電極４１の開放端４１ａに接続されて短手側縁２６ｂから垂下するストリップ状の容量装荷電極４８が形成され、その下端は、接地された固定電極５２と一定の間隔を介して対向しており、容量装荷電極４８と固定電極５２間に所定の開放端容量が形成される。

【００６４】また、基体２６の長手側縁２６ｄを形成する長手側面４７には、第２分岐放射電極４２の開放端４２ａに接続されて長手側縁２６ｄから中央脚３０の側面を垂下する容量装荷電極４９が設けられている。更に、長手側面４７には、脚２８の側面を利用し、第２無給電放射電極４４の開放端４４ａに接続されて長手側縁２６ｄから垂下する容量装荷電極５１が形成されている。

【００６５】同様に、基体２６に於ける長手側面４７と対向する長手側面４６には、３つの脚２８，２９，３０の夫々の側面を利用して第１無給電放射電極４３の開放端４３ｂに接続された容量装荷電極５０が長手側縁４３ｂから垂下して形成されている。なお、短手側面３４，３５の下部には、アンテナ装置を後述する回路基板に固定するための固定電極５２，５３が脚２８，２９の底面にも回り込んで形成されている。

【００６６】上述のアンテナ装置は、図５に示すように、無線通信機の回路基板５５に搭載される。アンテナ装置は、給電電極３６を回路基板５５の短辺５５ａに向け、その角部に寄せて設置され、基体２６の短手側縁２６ａが回路基板５５の短辺５５ａに沿って配置され、また、基体２６の長手側縁２６ｃが回路基板５５の長辺５５ｃに沿って配置されている。

【００６７】即ち、無給電素子３２に於ける無給電放射電極４３の開放端４３ｂが回路基板５５の長辺５５ｃに隣接し、且つ最遠の開放端４３ｃが、給電電極３６と同じ回路基板５５の短辺５５ａに隣接しており、スリット４３ａにより折り返した開放端４３ｃの方向は、アンテナ装置の給電電極３６から見た回路基板５５の長辺５５ｃの延長方向、換言すれば、短辺５５ａと対向するもう一つの短辺５５ｂの方向と逆の向きとなっている。

【００６８】また、無給電素子３３に於ける無給電放射電極４４の開放端４４ａは、回路基板５５の長辺５５ｃと対向する他方の長辺５５ｄの方向を向いており、給電電極３６から見た短辺５５ａの延長方向と同じ向きとなっている。

【００６９】上述の如くアンテナ装置が配置される回路基板５５には、アンテナ装置の実装位置に、給電端子３

６ａを接続する図示しない送受信回路の入出力端子となる配線パターン及び他の回路部品、例えば、インピーダンス整合回路を形成する回路部品を実装する配線パターンの周りを除き、グランドパターンが形成されており、アンテナ装置の基体２６に設けた脚２８，２９，３０の底面２８ａ，２９ａ，３０ａが固定される。

【００７０】即ち、給電端子３６ａは、送受信回路の入出力端子に半田付けされ、グランド端子３７ａ，３８ａ及び固定電極５２，５３がグランドパターンに半田付けされている。なお、これら半田付けに換えてバネ性弾力ピン等による接触でも良い。また、容量装荷電極４８，４９，５０，５１の先端は、グランドパターンと対向しており、容量装荷電極４８，４９，５０，５１とグランドパターンの間には、開放端容量が形成される。なお、回路基板５５には、単層又は積層回路基板が使用され、配線パターンを用いて無線周波の送受信回路及びベースバンド等の信号処理回路が形成される。

【００７１】上述の構成に於いて、給電電極３６にインピーダンス整合回路を介して信号電力が供給されると、給電素子３１は、２つの共振周波数ｆ１，ｆ２で励振される。即ち、実効線路長の長い第１分岐放射電極４１は、例えば、８００～９００ＭＨｚの周波数帯域に含まれる共振周波数ｆ１で励振され、実効線路長の短い第２分岐放射電極４２は、第１分岐放射電極４１の共振周波数ｆ１よりも高い、例えば、１８００～１９００ＭＨｚの周波数帯域に含まれる共振周波数ｆ２で励振される。

【００７２】この２つの共振周波数ｆ１，ｆ２は、開放端４１ａ，４２ａ方向に向かって拡大するスリット４０ａにより第１分岐放射電極４１と第２分岐放射電極４２との間の電界結合が緩和され、また、容量装荷電極４８，４９とグランドパターン間の容量結合を適切に設定することにより、独立した共振周波数として共存する。換言すれば、給電素子３１は、２つの分岐放射電極４１，４２と、２つの容量装荷電極４８，４９と、給電電極３６とで決まる２つの電気長により、互いに独立した２つの共振特性を持っている。

【００７３】また、無給電素子３２は、給電素子３１との電磁結合により励振電力の供給を受ける。換言すれば、無給電素子３２は、主として、給電電極３６とグランド電極３７の部分に於ける電流（磁界）結合と、無給電放射電極４３と第１分岐放射電極４１間の電界結合と、３本の容量装荷電極５０とグランドパターン間の容量結合により共振周波数ｆ３で励振される。この共振周波数ｆ３は、第１分岐放射電極４１の共振周波数ｆ１と同じ周波数帯域、例えば、８００～９００ＭＨｚの周波数帯域内に設定されている。

【００７４】このとき、第１無給電放射電極４３は、第１分岐放射電極４１よりも若干低い共振周波数ｆ３で共振しており、給電素子３１と無給電素子３２は、共振周波数ｆ１，ｆ３で複共振する。ここに、共振周波数ｆ１，ｆ３が複共振して形成した周波数帯域幅は、単一の共振周波数ｆ１，ｆ３の共振特性に比べて広い周波数帯域幅となる。

【００７５】また、第１無給電放射電極４３の最遠の開放端４３ｃに向かって流れる共振電流により、回路基板５５の長辺５５ｃに沿って筐体電流が励起される。この筐体電流は、回路基板５５の長辺５５ｃの長さが、使用する電波の波長λの約半分の長さ（λ／２）であるとき、無給電素子３２の利得を高くする。従って、回路基板５５の長辺５５ｃの長さは、高利得化を実現する共振周波数の波長にほぼ一致していることが望ましい。

【００７６】更に、第１無給電放射電極４３を回路基板５５の長辺５５ｃに近接して配置したことにより、開放端４３ｂ，４３ｃとグランドパターンとの電界結合が減少して共振特性の電気的Ｑが低くなり、周波数帯域幅が広くなる。

【００７７】同様に、無給電素子３３は、給電素子３１との電磁結合により励振電力の供給を受ける。即ち、無給電素子３３は、主として、給電電極３６とグランド電極３８の部分に於ける電流（磁界）結合と、第２無給電放射電極４４と第２分岐放射電極４２との電界結合と、容量装荷電極５１とグランドパターン間の容量結合により共振周波数ｆ４で励振される。この共振周波数ｆ４は、第２分岐放射電極４２の共振周波数ｆ２と同じ周波数帯域、例えば、１８００～１９００ＭＨｚの周波数帯域内に設定されている。

【００７８】この第２無給電放射電極４４は、第２分岐放射電極４２よりも若干低い共振周波数ｆ４で励振する。そして、給電素子３１と無給電素子３３は、共振周波数ｆ２，ｆ４で複共振し、そのときの周波数帯域幅は、単一の共振周波数ｆ２，ｆ４の共振特性に比べて広くなる。このとき、第２無給電放射電極４４の開放端４４ａに向かって流れる共振電流により、回路基板５５の短辺５５ａに沿って筐体電流が励起される。

【００７９】この筐体電流により、無給電素子３３に於ける利得が高くなる。また、第２無給電放射電極４４を回路基板５５の短辺５５ａに近接して配置したことにより、開放端４４ａとグランドパターンとの電界結合が減少して共振特性の電気的Ｑが低くなり、広い周波数帯域を持った共振特性となる。この結果、複共振特性の周波数帯域幅も広くなる。

【００８０】上述に於いて、給電素子３１の第１分岐放射電極４１と第１無給電放射電極４３の組合せは、第１周波数帯域を形成する第１複共振ペアを構成し、第２分岐放射電極４２と第２無給電放射電極４４の組合せは、第１周波数帯域から離れ且つ第１周波数帯域よりも高い周波数の第２周波数帯域を形成する第２複共振ペアを構成する。従って、アンテナ装置は、何れの周波数帯域に於いても複共振して双峰の共振特性となって広帯域幅を実現したデュアルバンドのアンテナとなる。

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【００８１】なお、基体２６は、天板２７を脚２８，２９，３０で支持した構成であるので、基体２６の軽量化を図ることができると共に、中央脚３０と両側の脚２８，２９との間の空間を利用して、例えば、送受信回路の一部となる回路を配置することができる。また、天板２７の厚味は、脚２８，２９，３０の高さよりも薄くなるので、基体２６の高さに拘わらず、基体２６の実効比誘電率を下げることができる。従って、給電素子３１と無給電素子３２，３３間の過度の電界結合を制御でき、アンテナ特性の向上を図ることができる。

【００８２】図６及び図７を用いて本発明に係るアンテナ装置の具体的な第２実施形態例を説明する。なお、図４の第１実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。この実施形態例の特徴は、回路基板の１つの短辺とアンテナ装置の幅をほぼ等しく構成したことにある。

【００８３】図６に於いて、携帯電話の筐体に組込む回路基板５６は、筐体の幅に合わせて、長辺５６ｃ，５６ｄと短辺５６ａ，５６ｂの比が２～４程度に作製される。この回路基板５６に実装されるアンテナ装置の基体５７は、その長手側縁５７ｃが回路基板５６の１つの短辺５６ａに沿って配置され、短手側縁５７ａ，５７ｂが回路基板５６の長辺５６ｃ，５６ｄに沿う配置となる。このアンテナ装置に於ける基体５７の長手側縁５７ｃ，５７ｄの長さは、回路基板５６の短辺５６ａ，５６ｂと同じか或いは若干短い寸法である。

【００８４】また、基体５７は、底面５８側に開口５８ａを設けた箱状の形態であり、側壁５９の高さに比べて天板６０部分の厚みは薄く構成されている。基体５７の表面６０ａには、図４と同様に、給電素子６１及び無給電素子６２，６３が形成されている。これらの給電素子６１及び無給電素子６２，６３は、図４の場合とは異なり、給電電極３６及びグランド電極３７，３８が、長手壁面５９ｃの一方側に片寄らせて、基体５７の長手側面５９ｃに設けられている。

【００８５】また、グランド電極３７の上端に接続された無給電放射電極４３は、長手側縁５７ｃから対向する長手側縁５７ｄまで延び、スリット４３ａにより区画された開放端４３ｂ，４３ｃは、基体５７の右側の短手壁面５９ａに設けた容量装荷電極５０に接続されている。一方、グランド電極３８に接続された無給電放射電極４４は、長手側縁５７ｃに沿って左側の短手側縁５７ｂまで延びており、その開放端４４ａは、短手壁面５９ｂに設けた容量装荷電極５１に接続されている。

【００８６】無給電放射電極４３と無給電放射電極４４の間には、図４と同様に、給電素子６１を形成する給電放射電極４０が分岐放射電極４１，４２の形態で設けられており、開放端４１ａは、長手壁面５９ｄに設けた容量装荷電極４８に接続され、また、開放端４２ａは、短手壁面５９ｂに設けた容量装荷電極４９に接続されている。

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【００８７】上述の構成に於いて、第１分岐放射電極４１と無給電放射電極４３は、複共振ペアを構成する放射電極として構成されており、例えば、８００～９００ＭＨｚ帯の周波数で複共振している。また、第２分岐放射電極４２と無給電放射電極４４も、例えば、１８００～１９００ＭＨｚ帯の周波数で複共振する放射電極であり、複共振ペアとなっている。

【００８８】また、無給電放射電極４３の開放端４３ｂを回路基板５６の長辺５６ｃに沿って配置すると共に、最遠の開放端４３ｃを長辺５６ｃの延長方向（短辺５６ｂ側）と反対向き、即ち、グランド電極３７が位置する短辺５６ａ側の長手側縁５７ｃで終端する構成であるから、回路基板５６の長辺５６ｃに沿って低い周波数帯域側に属する筐体電流が励起され、アンテナの利得が著しく向上する。

【００８９】同様に、高い周波数帯域側に属する無給電放射電極４４を、回路基板５６の短辺５６ａに沿って配置し且つ短辺５６ａの延長方向と同じ方向に伸張して、その開放端４４ａが回路基板５６の長辺５６ｄ側の短手側縁５７ｂで終端する。これにより、回路基板５６の短辺５６ａ側の基板端に高周波側に属する筐体電流、即ち、１８００～１９００ＭＨｚ帯の周波数を持った筐体電流が励起され、高い周波数帯域に於ける利得を高くする。

【００９０】上述した筐体電流の励起に際して、無給電放射電極４３，４４を回路基板５６の基板端に配置したことにより、無給電放射電極４３，４４と回路基板５６との電界結合が緩和されるので、共振特性の電気的Ｑが過度に高くなるのを抑制することができ、帯域幅を広げることができる。また、無給電放射電極４３の開放端４３ｂは回路基板５６の長辺５６ｃ側に位置し、無給電放射電極４４の開放端４４ａは回路基板５６の長辺５６ｄ側に位置して、最も離れた配置関係となり、２つの複共振ペア間の相互干渉が著しく小さくなり、複共振特性の劣化を防止することができる。

【００９１】図８は、図７に示すアンテナ装置の変形例を示す。なお、図７の第２実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。この実施形態例は、給電放射電極４０に形成したスリット４０ａを大きく広げて構成した点に特徴がある。

【００９２】図８に於いて、給電電極３６及びグランド電極３７，３８は、基体５７の長手壁面５９ｃに於ける長手方向の中央部分に図７と同様に設けられている。分岐放射電極４１は、長手側縁５７ｃから対向する長手側縁５７ｄの右端位置の角部分に向けて伸張し、長手側縁５７ｄと短手側縁５７ａに開放端４１ａを有して、長手壁面５９ｄに設けた容量装荷電極６６及び短手壁面５９ａに設けた容量装荷電極４８に接続されている。容量装荷電極６６の先端は、一定の間隔を介して固定電極６８

と対向している。

【００９３】一方、分岐放射電極４２は、長手側縁５７ｄの左端位置の角部分に向けて伸張して、長手側縁５７ｄと短手側縁５７ｂに開放端４２ａを有しており、長手壁面５９ｄに設けた容量装荷電極６７及び短手壁面５９ｂに設けた容量装荷電極４９に接続されている。容量装荷電極６７の先端は、上述同様に、一定の間隔を介して固定電極６９と対向している。

【００９４】また、分岐放射電極４１，４２を分けるスリット４０ａは、給電電極３６側から長手側縁５７ｄに向かって大きく開いた形態であり、分岐放射電極４１，４２に於ける２つの共振周波数間の相互干渉、換言すれば、分岐放射電極４１と無給電放射電極４３の複共振ペアと分岐放射電極４２と無給電放射電極４４の複共振ペア間の相互干渉を小さくする。

【００９５】無給電放射電極４３は、右側の短手側縁５７ａに向かって伸張し、その開放端４３ｂ，４３ｃは短手側縁５７ａ及び長手側縁５７ｃで終端し、開放端４３ｂは２つの容量装荷電極５０に接続されている。また、無給電放射電極４４は、左側の短手側縁５７ｂに向かって延び、短手側縁５７ｂに位置する開放端４４ａは、短手壁面５９ｂに設けた２本の容量装荷電極５１に接続されている。

【００９６】この構成に於いては、２つの分岐放射電極４１，４２の開放端４１ａ，４２ａが最大限に引き離されるので、２つの複共振ペア間の帯域分離が良くなり、各複共振ペアに於ける特性が向上する。また、アンテナ装置は、図６同様の形態で回路基板５６に実装され、上述同様に基板端５６ａ，５６ｃに筐体電流を励起するので、各複共振ペアに於ける利得が向上する。

【００９７】図９は、本発明に係るアンテナ装置の具体的な第３実施形態例を示す。なお、図４に示す第１実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。この実施形態例の特徴は、給電素子に単一の給電放射電極を用いた点にある。

【００９８】図９に於いて、給電素子７１は、給電電極３６の上端を給電端７２ａとする単一の給電放射電極７２として構成されている。給電放射電極７２の面中には、放射電極の伸張方向の側縁側から複数のスリット７２ｂが設けられており、給電放射電極７２の実効線路長が適宜に設定されている。給電放射電極７２の開放端７２ｃには、短手側面３５に設けた容量装荷電極４８が接続されると共に、長手側面４７に設けた容量装荷電極７３が接続されている。容量装荷電極４８は固定電極５２との間で静電容量を与え、容量装荷電極７３は回路基板のグランドパターンとの間に静電容量を形成する。

【００９９】この給電素子７１は、給電電極３６を介して信号電力が供給されると、基本波の共振周波数で励振されると共に、基本波の高次高調波、例えば、２倍波又は３倍波の共振周波数で励振される。基本波の共振周波数は、無給電素子３２の共振周波数と同じ周波数帯域に属し、給電素子７１と無給電素子３２は複共振する。また、給電素子７１に於ける高次高調波の共振周波数は、無給電素子３３の共振周波数と同じ周波数帯域に属しており、無給電素子３２よりも高い周波数で給電素子７１と無給電素子３３は複共振する。なお、上述では、給電放射電極７２に於ける基本波と高次高調波の設定をスリット７２ｂの形成で行う形態例を示したが、これに限定されるものではない。

【０１００】上述の実施形態例では何れも、給電電極３６に給電放射電極４０，７２を接続した形態を示したが、給電電極３６の上端を給電放射電極４０，７２から切り離し、一定の間隔（ギャップ）を設けて容量結合する構成としても良い。

【０１０１】また、図１０に示すように、分岐放射電極４１，４２の開放端４１ａ，４２ａ側の基体７５の側面に給電電極７４を設けることができる。この給電電極７４の先端は、一定の間隔を介して開放端４１ａ，４２ａと近接しており、分岐放射電極４１，４２と容量結合する。この給電構造では、分岐放射電極４１，４２の根本端４０ｂは、グランド電極を介して接地される。換言すれば、上述の実施形態例に於ける給電電極３６は、グランド電極として使用される。

【０１０２】更に、図１１に示すように、分岐放射電極４１，４２の根本部分のほぼ５０Ωとなる位置に、基体２６の天板２７を貫通して給電ピン７６を立て、分岐放射電極４１，４２に信号電力を供給する構成としても良い。給電ピン７６の下端は、回路基板５５に設けた給電パターン７７に接続される。この給電構造に於いても、給電電極３６をグランド電極に置換する以外は、図４と同じである。

【０１０３】図１２は、本発明に係るアンテナ装置の具体的な第４実施形態例を示す。このアンテナ装置は、回路基板に２つの単アンテナを実装してデュアルバンドのアンテナを構成した点に特徴がある。

【０１０４】図１２に於いて、回路基板８０の上に２つの単アンテナ８１，８２が一定間隔離して実装されている。これらの単アンテナ８１，８２は、夫々、基体８７，８８を用いて形成した給電素子８３，８４及び無給電素子８５，８６を備えている。そして、給電素子８３，８４が隣接し、無給電素子８５，８６が給電素子８３，８４の外側に配置される構成である。なお、基体８７，８８の構成は、図７と同様である。

【０１０５】単アンテナ８１は、基体８７の短手側面に、上下に延びる給電電極８９とグランド電極９１を備えており、この給電電極８９とグランド電極９１は、左に給電電極８９が位置し、右にグランド電極９１が位置する如く近接して配設されている。また、基体８７の表面には、グランド電極９１の上端に接続した無給電放射電極９５が、基体８７の長手方向に同じ幅で真っ直ぐに

伸張して図４と同様に構成され、その開放端は、基体８７の長手側面に設けた容量装荷電極９７に接続されている。

【０１０６】一方、基体８７に設けた給電放射電極９３は、給電電極８９の上端から基体８７の長手方向に且つ無給電放射電極９５から離れるように次第に湾曲して伸張して設けられている。給電放射電極９３の開放端は、単アンテナ８２に面する側の長手側面に於いて、給電電極８９に近い位置に設けた容量装荷電極９８に接続されている。なお、給電放射電極９３の面中には、給電電極８９側からスリット９３ａが設けられ、給電放射電極９３の実効線路長の調整が行われている。

【０１０７】また、単アンテナ８２では、単アンテナ８１と同様に、給電電極９０及びグランド電極９２が、右に給電電極９０を、左にグランド電極９２を配置して基体８８の短手側面に設けられている。基体８８の表面には、グランド電極９２の上端に接続した無給電放射電極９６が、基体８８の左側を長手方向に向かって同じ幅で伸張しており、その先端側の開放端には、基体８８の長手側面に設けた容量装荷電極９９が接続されている。

【０１０８】そして、給電放射電極９４は、給電電極９０の上端から基体８８の長手方向の途中まで伸張した後、無給電放射電極９６から急激に離れるように円弧状に湾曲して設けられている。即ち、給電放射電極９４の実効線路長は、給電放射電極９３の実効線路長よりも短く構成されている。給電放射電極９４の開放端には、単アンテナ８１側に面する長手側面に、給電電極９０側に寄せて設けた容量装荷電極１００に接続されている。なお、１０１は固定電極である。

【０１０９】２つの単アンテナ８１，８２を実装した回路基板８０には、基板端部分に設けられた共通の給電端子パターン１０２と、この給電端子パターン１０２に接続された給電パターン１０３，１０４とが形成されている。給電パターン１０３には、単アンテナ８１の給電電極８９が接続され、また、給電パターン１０４には、単アンテナ８２の給電電極９０が接続されている。なお、グランド電極９０，９１及び固定電極１０１は、図示しないグランドパターンに接続されており、また、各容量装荷電極９７，９８，９９，１００の先端は、図示しないグランドパターンと対向している。

【０１１０】上述の構成に於いて、単アンテナ８１の給電素子８３と無給電素子８５は、同じ周波数帯域、例えば、８００～９００ＭＨｚの周波数帯域で複共している。また、単アンテナ８２の給電素子８４と無給電素子８６も、単アンテナ８１の周波数帯域よりも高い周波数の同じ周波数帯域、例えば、１８００～１９００ＭＨｚの周波数帯域で複共している。従って、アンテナ装置は、図４に示す給電素子３１の如く、恰も、給電放射電極９３，９４が給電端子パターン１０２を根本部分とした分岐電極と同様の働きをする。

【０１１１】また、この回路基板８０を用いて構成したアンテナ装置は、回路基板８０の広さに応じて、単アンテナ８１，８２間の間隔を広げる構成とすることができ、単アンテナ８１，８２間の相互干渉を十分に小さくすることができる。また、用途に応じて要求されるアンテナ装置の電気的体積も、回路基板８０の寸法で決めることができ、単アンテナ８１，８２の配置変更も容易に行うことができる。

【０１１２】また、図１２の実施形態例で示すアンテナ装置には、図１３に如く、給電パターン１０３，１０４の途中に、帯域遮断回路１０５，１０６を設けることができる。即ち、帯域遮断回路１０５は、単アンテナ８２の周波数帯域に属する信号を遮断し、単アンテナ８１の周波数帯域に属する信号を通過させるフイルタ回路である。また、帯域遮断回路１０６は、単アンテナ８１の周波数帯域に属する信号を遮断し、単アンテナ８２の周波数帯域に属する信号を通過させるフイルタ回路である。

【０１１３】この回路構成により、各単アンテナ８１，８２は、夫々の周波数帯域に於ける励振条件のみを考慮して給電素子を形成することができ、複共振の整合が容易になる。

【０１１４】図１２及び図１３に示す実施形態例に於いて、単アンテナ８１，８２を、図４に示すアンテナ装置に置換して構成することができる。即ち、単アンテナ８１，８２の夫々を給電素子の両側に無給電素子を配設した構成とする。このアンテナ装置は、各単アンテナ８１，８２が、夫々２つの周波数帯域を持ったデュアルバンドのアンテナを構成するので、合計４つの周波数帯域を持つマルチバンドのアンテナとなる。従って、このアンテナ装置を無線通信機に搭載することにより、各周波数帯域を順次切換えて使用したり、また、同時に使用することができる。

【０１１５】また、図１３に示すアンテナ装置の単アンテナ８１，８２と同様の構成の単アンテナ１０７を追加して構成することができる。単アンテナ１０７は、図１４に示すように、単アンテナ８１，８２の間に配置されており、その給電電極は、給電パターン１０８を介して給電端子パターン１０２に接続されている。給電パターン１０８の途中には、単アンテナ８１，８２と同様に、フイルタ回路１０９が設けられている。

【０１１６】単アンテナ１０７の給電素子と、無給電素子も複共振しており、アンテナ装置は、３つの周波数帯域を持つアンテナ装置となる。例えば、単アンテナ８１を８００～９００ＭＨｚの周波数帯域に割当てたとき、単アンテナ１０７に１８００～１９００ＭＨｚの周波数帯域を、また、単アンテナ８２には、２７００～２８００ＭＨｚの周波数帯域を割当てた構成とすることができる。

【０１１７】

【発明の効果】請求項１のアンテナ装置によれば、給電

素子に沿わせて無給電素子を近接配置するので、夫々の無給電素子と給電素子間の最適な電磁界結合を各無給電素子毎に設定することができ、各無給電素子の共振周波数が属する周波数帯域毎に良好な複共振を実現することができる。従って、従来例のような２つの周波数帯域を夫々単一共振特性とするアンテナに比べて、各周波数帯域に於ける帯域幅は格段に広くなるので、アンテナ装置の広帯域化が可能となる。これに伴って、アンテナ装置を小型化及び低背化することができる。

【０１１８】請求項２のアンテナ装置によれば、給電放射電極を複数の分岐放射電極として構成するので、１つの給電素子に、異なる周波数帯域に属する複数の共振周波数を共存させることができる。また、各分岐放射電極は、夫々の実効線路長を有するので、個別に共振周波数を設定することができる。

【０１１９】請求項３のアンテナ装置によれば、各分岐放射電極は、互いに異なる共振周波数で励振する実効線路長を備えるので、各々の共振周波数が属する周波数帯域が重ならない範囲で自由に共振周波数を設定でき、分岐放射電極毎に使用する周波数を割当てることができる。

【０１２０】請求項４のアンテナ装置によれば、１つの給電放射電極に、基本波の共振周波数及びその高次高調波の共振周波数で励振する実効線路長を備えるので、共振周波数毎に分岐放射電極を設ける必要がなく、その分、アンテナ装置の体積を小さくし、アンテナ装置を小型化することができる。

【０１２１】請求項５のアンテナ装置によれば、給電素子に於ける隣接する分岐放射電極の開放端側の間隔を広げた構成とするので、複共振ペア間の相互干渉による複共振特性の劣化、特に、周波数帯域幅の縮小及びアンテナ利得の低下を防ぐことがでる。

【０１２２】請求項６のアンテナ装置によれば、放射電極の開放端に容量装荷電極を設けたので、各放射電極に於ける開放端容量が確定値として得られ、これにより、各放射電極に於ける共振周波数の設定が容易となり、良好な複共振マッチングを得ることができる。

【０１２３】請求項７のアンテナ装置によれば、少なくとも２つの無給電放射電極は、夫々、回路基板の端辺に沿って配置されるので、これらの無給電素子を高利得化することができると共に、夫々の無給電素子に於いて広帯域化を実現することができる。

【０１２４】請求項８のアンテナ装置によれば、回路基板に複数のアンテナを実装して構成するので、アンテナの体積を回路基板の寸法で決めることができ、アンテナ装置の大型化が自在になると共に、夫々のアンテナのレイアウト変更が容易になるなど、アンテナ装置の設計が容易になる。

【０１２５】請求項９のアンテナ装置によれば、各アンテナにはフィルタ回路を介して信号電力が供給されるので、夫々のアンテナ毎に整合の取れた給電素子の設計が容易となる。

【０１２６】請求項１０のアンテナ装置によれば、各アンテナを夫々２つの周波数帯域で複共振するアンテナとして構成するので、容易にマルチバンドのアンテナを実現することができると共に、無線通信機に於けるアンテナ搭載のスペースを小さくすることができる。

【０１２７】請求項１１のアンテナ装置によれば、給電端子部の構成の選択幅が広がるので、アンテナ装置の設計が容易になる。

【０１２８】請求項１２の無線通信機によれば、アンテナ装置の幅を回路基板の短辺の長さとほぼ等しく構成すると共に、アンテナ装置を回路基板の３方の端辺に沿って配置するので、回路基板のスペースを有効利用できると共に回路基板に筐体電流を励起してアンテナ装置の広利得化を図ることができる。また、無給電放射電極の開放端を可能な限り遠ざけ且つ電界結合を抑制した配置としたので、広帯域の複共振が得られ、また、周波数帯域間の干渉を小さくすることができる。

【０１２９】請求項１３の無線通信機によれば、低い周波数の無給電放射電極に於ける最遠の開放端側を回路基板の長辺の最遠端方向と逆向きに設けたので、回路基板を低い周波数のアンテナとして活用することができ、アンテナの高利得化が達成できる。

【０１３０】請求項１４の無線通信機によれば、複共振により広い周波数帯域を有し且つ複数の周波数帯域を有するアンテナ装置を用いるので、複数の周波数帯域を用いた無線通信を１つのアンテナ装置で実現することができ、無線通信機の一層の小型化が可能となる。

【図面の簡単な説明】

【図１】本発明に係るアンテナ装置の基本構成を示す概略説明図である。

【図２】図１に於けるアンテナ装置のリターンロスを示す周波数特性図である。

【図３】本発明に係るアンテナ装置の基本構成を示す他の概略説明図で、（Ａ）は表面図、（Ｂ）は裏面図である。

【図４】本発明に係るアンテナ装置の実施形態例を示し、（Ａ）は表面斜視図、（Ｂ）は裏面斜視図である。

【図５】図４のアンテナ装置を無線通信機の回路基板に実装した実施形態例を示す平面図である。

【図６】アンテナ装置を無線通信機の回路基板に実装した他の実施形態例を示す平面図である。

【図７】本発明に係るアンテナ装置の他の実施形態例を示し、（Ａ）は表面斜視図、（Ｂ）は裏面斜視図である。

【図８】本発明に係るアンテナ装置の更に他の実施形態例を示し、（Ａ）は表面斜視図、（Ｂ）は裏面斜視図である。

【図９】本発明に係るアンテナ装置の更に他の実施形態

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例を示し、（Ａ）は表面斜視図、（Ｂ）は裏面斜視図である。

【図１０】本発明のアンテナ装置に係る給電端子部の他の構成を示す斜視図である。

【図１１】本発明のアンテナ装置に係る給電端子部の更に他の構成を示し、(A)は平面図、(B)は(A)の一点破線Ｘ－Ｘに於ける断面図である。

【図１２】本発明に係るアンテナ装置の更に他の実施形態例を示し、(A)は表面斜視図、(B)及び(C)は(A)で用いた単アンテナの裏面斜視図である。

【図１３】図１２のアンテナ装置に係る他の実施形態例を示す斜視図である。

【図１４】本発明に係るアンテナ装置の更に他の実施形態例を示す平面図である。

【図１５】従来例のアンテナ装置を示す斜視図である。

【符号の説明】

１０，２６，５７，７５，８７，８８　基体

１１，３１，６１，７１，８３，８４　給電素子

１２，１３，２５，３２，３３，６２，６３，８５，８６　無給電素子

１４，４０，７２，９３，９４　給電放射電極

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１６，１７，２４，４１，４２，　分岐放射電極

１６ｂ，１７ｂ，１８ｂ，１９ｂ，４１ａ，４２ａ，４３ｂ，４３ｃ，４４ａ，７２ｃ　開放端

１８，１９，４３，４４，９５，９６，２５ａ　無給電放射電極

２２　信号源

２３　インピーダンス整合回路

３６，７４，８９，９０　給電電極

３７，３８，９１，９２　グランド電極

４３ａ　スリット

４８，４９，５０，５１，６６，６７，７３，９７，９８，９９，１００　容量装荷電極

５５，５６，８０　回路基板

５５ａ，５５ｂ，５６ａ，５６ｂ　短辺

５５ｃ，５５ｄ，５６ｃ，５６ｄ　長辺

７６　給電ピン

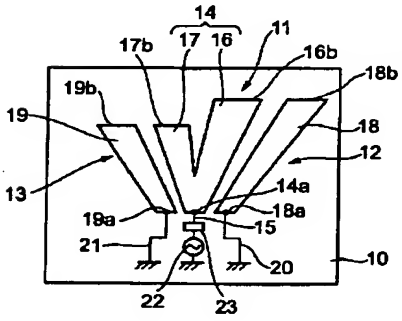
７７，１０３，１０４，１０８　給電パターン

８１，８２，１０７　単アンテナ

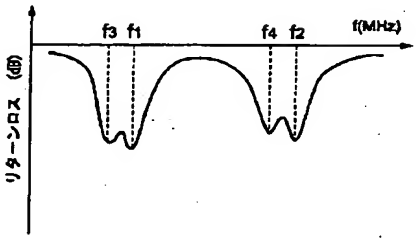
１０２　給電端子パターン

１０５，１０６，１０９　帯域遮断回路

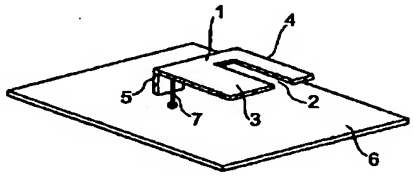
【図１】



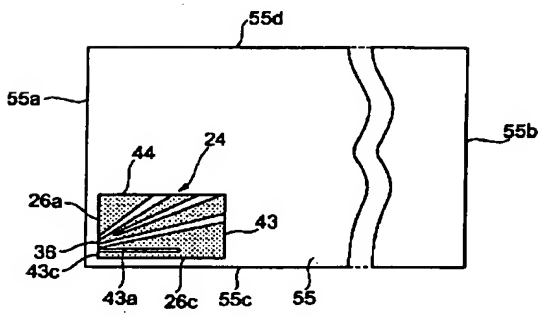
【図２】



【図１５】



【図５】



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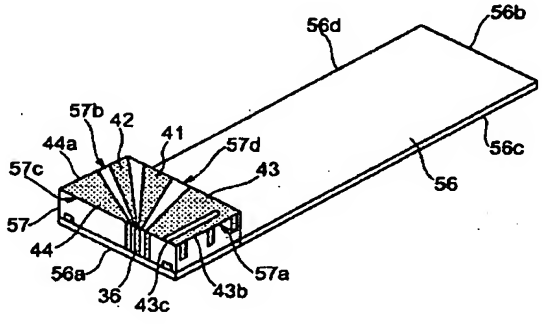

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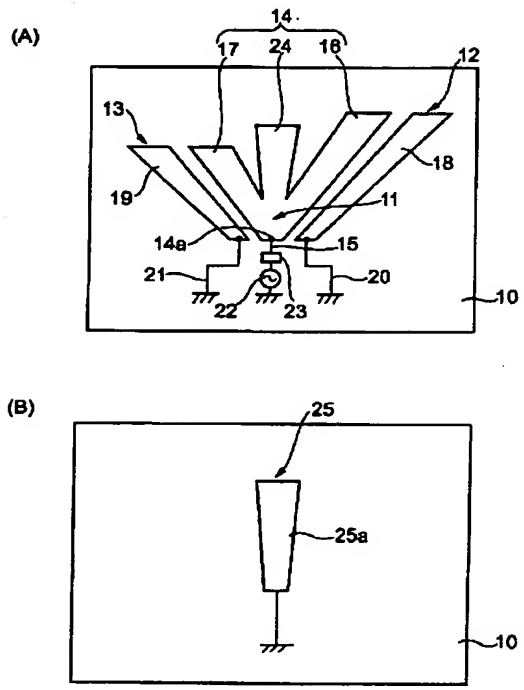
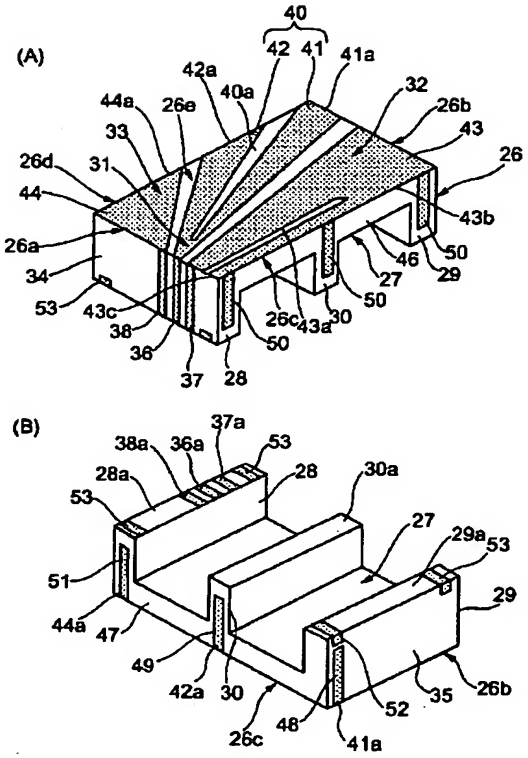
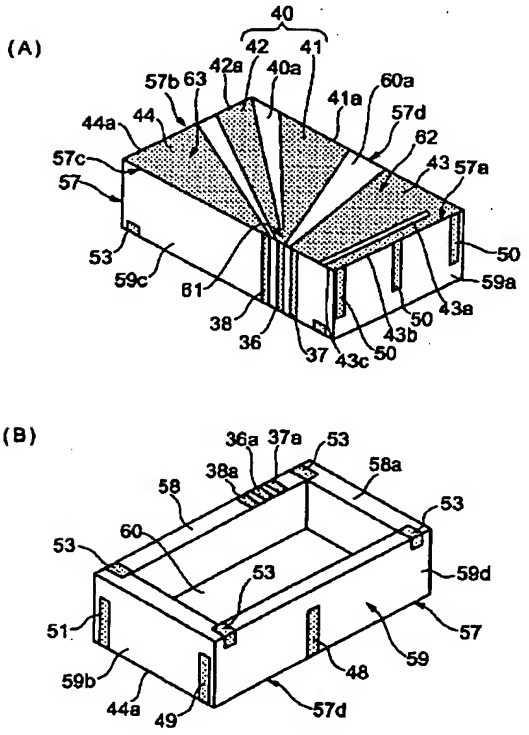

(A)
14
17
24
16
12
13
18
19
11
14a
15
21
20
22
23
10
(B)
25
25a
10

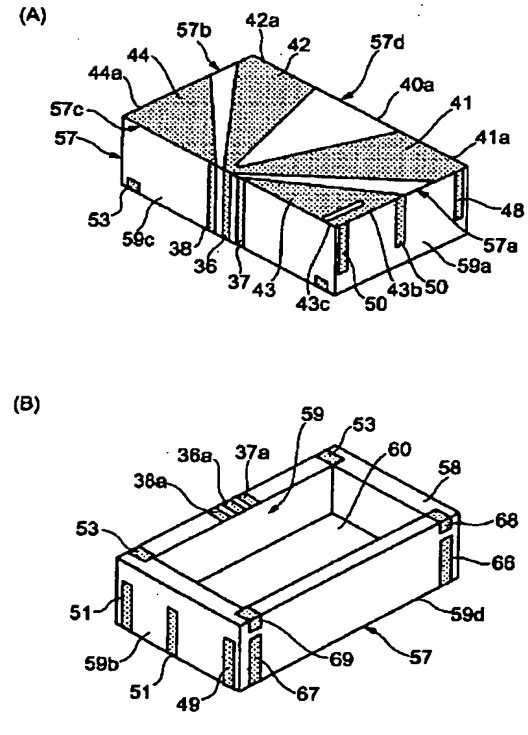
【図４】


(A)
40
42
41
41a
42a
40a
44a
26e
32
26b
33
43
26d
31
26
44
43b
26a
46
50
34
27
29
53
43c
50
26c
43a
30
38
50
36
37
28
(B)
37a
38a
36a
53
28a
28
30a
53
27
29a
53
51
29
44a
47
49
42a
30
52
35
26b
48
26c
41a

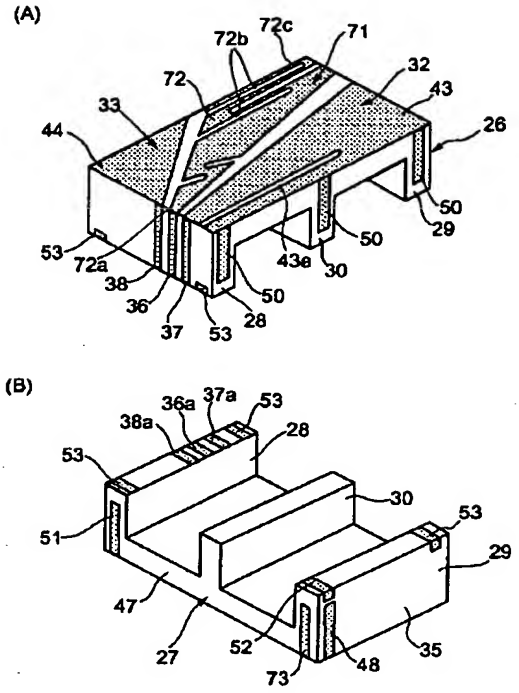
【図７】


(A)
40
42
41
57b
63
42a
40a
60a
41a
57d
44a
44
62
43
57a
57c
57
50
53
59c
59a
61
43a
38
50
36
43b
37
43c
50
(B)
36a
37a
53
38a
58a
58
53
60
53
59d
53
51
57
59
59b
48
44a
49
57d

【図８】


(A)
57b
42a
42
57d
44
44a
40a
41
57c
57
41a
48
53
59c
57a
38
59a
36
37
43
43b
50
43c
50
(B)
59
53
36a
37a
60
58
38a
68
53
66
51
59d
59b
69
57
51
49
67

【図９】



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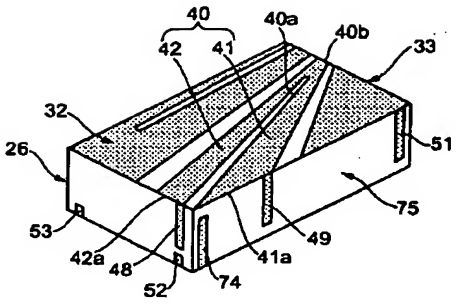
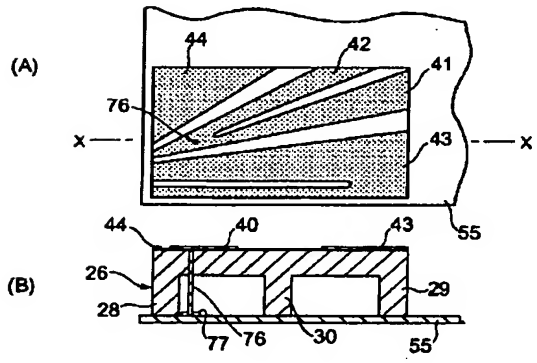


【図１１】



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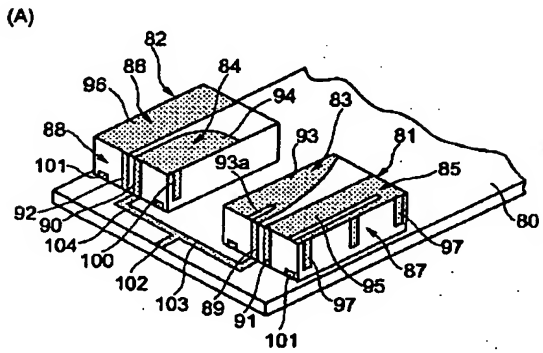

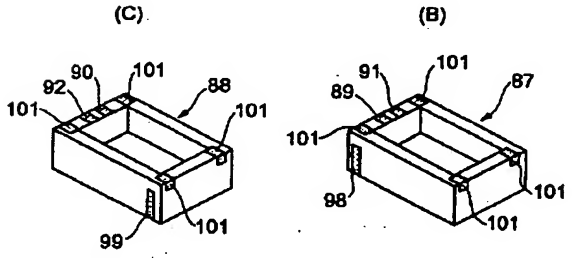

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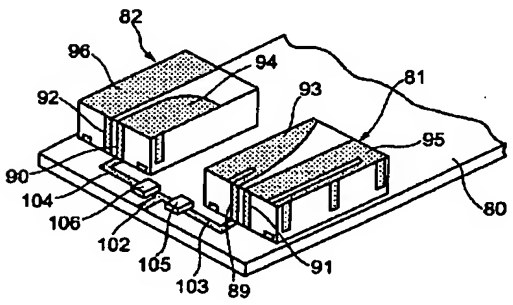

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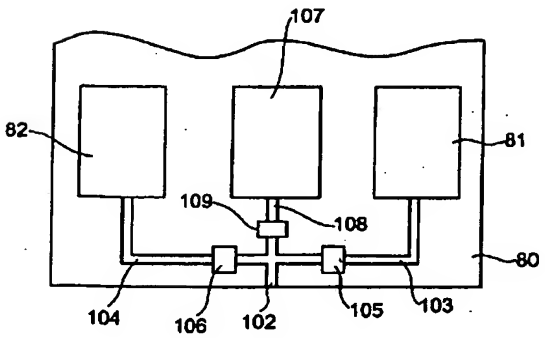

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21/30		21/30	

(72)発明者　石原　尚
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(72)発明者　佐藤　仁
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内

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